aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • FALL 1981

NASA SKY EYES:
Orbiting Observatories

Notable views of notable people on aerospace matters...

aerospace perspectives

Richard V. Allen, *Assistant to the President for National Security Affairs, at the 35th National Convention of the Air Force Association in Washington, D.C.:*

"In the early 1960s . . . critics argued that the strategic bomber had lost its effectiveness in an age of ICBMs and sophisticated Soviet air defense systems. They argued that the manned bomber, a strategic dinosaur, had essentially outlived its environment and ought no longer be a component of our forces. These critics were wrong then, and they are wrong now . . .

The manned bomber provides an invaluable dimension of our strategic triad. Only the combat-proven bomber is usable in different types and levels of conflicts, from brushfire scraps to general nuclear war. The bomber keeps us protected from an enemy antiballistic missile system breakout. It brings human intelligence to bear in the combat zone, for damage assessment and the attack of mobile and immediate targets. Perhaps most important, if war threatens the manned bomber can be launched and then recalled, providing us with a critical tool for prudent crisis management."

General Lew Allen, Jr., *Chief of Staff, USAF, speaking at the Air Force Association convention:*

"The question is: can we afford a defense capability adequate to the challenge posed by the Soviet Union?

"Clearly, the challenge is difficult and requires a major effort on our part, since the Soviets show great ability to create and maintain a massive military machine, and great determination to pay the price for a steady growing military capability.

"Nevertheless, unless we are willing to bear the burden, the risk of significant U.S. inferiority is very real and the dangers associated with such inferiority ominous. To rebuild our defenses and maintain an adequate balance of military capabilities with our principal adversary will require some sacrifices by U.S. citizens. But the sacrifice is clearly bearable. For example, American spending on alcoholic beverages has exceeded Air Force expenditures in each of the past five years and casino gambling revenues are currently running double the Air Force's annual fuel bill . . .

"We can afford the expense of defense. It is the cost of a loss of our freedom which would be unbearable."

General Robert C. Mathis, *Vice Chief of Staff, USAF, at the Air Force Association convention:*

"Some have alleged there is substantial waste in the defense budget. Frequently these assertions are made by individuals who have little or no understanding of operational reality . . .

"Seldom mentioned is the fact that our people, through their over 90,000 suggestions, saved the Air Force $76 million last year . . . Our people have pioneered efforts to conserve energy; their ideas and innovations have already resulted in $720 million in energy savings and could reach $1 billion. . . . Investment funding of productivity, reliability, availability and maintainability (PRAM) efforts totaled $49 million through fiscal year 1980, with an expected five-year savings of $1.1 billion. These are but a few examples of the kinds of things our innovative Air Force people are doing to insure the best use of our resources . . . I challenge any critic to find a more creative or innovative group of people."

General Robert T. Marsh, *Commander, Air Force Systems Command, before a meeting of the Association for Unmanned Vehicle Systems in Washington, D.C.:*

"Simplicity versus complexity is currently a 'hot item' . . . After all, who can be against simplicity? Could any decision maker be an advocate of complexity for its own sake? Of course not . . . It's a trap we may fall into if we accept the words 'simple' and 'complex' out of context. To me, sophistication and complexity must equate to high performance and improved capability when applied to a weapon system; otherwise we share the naïveté of those that espouse as a truism 'simple is better.'

"The simplicity-complexity argument is by means new, and although appealing on the surface it holds no more validity today than when the longbow was first introduced to replace the spear. In those days, too, you can be sure some of the analysts close to the palace throne must have objected. They probably argued: the new weapon system is more complex, has more moving parts, and will require sophisticated operators with better training. It will have a longer tooth-to-tail ratio. We will have to establish a new personnel specialty code for fletchers to glue feathers on arrows. . . .

"They missed the same point as some of our modern-day analysts. And that point, of course, is that more complex systems may yield increased effectiveness and greater survivability. . . . The consequences of complexity are in the eyes of the beholder. There is no question that, using today's technology, we can design simple systems which are cheaper and easier to maintain than our more complex designs. But if these simple alternatives cannot meet the conditions of future threats, they will not be effective."

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PRESIDENT • Karl G. Harr, Jr.
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EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • James J. Haggerty
Jean Ross Howard
ART DIRECTOR • James J. Fisher

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On the cover: NASA's Space Telescope, centerpiece of a new thrust in space-based astronomy, will look seven times farther into the universe than the best Earth-base telescopes.

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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Aeronautical Research—
INVESTMENT IN THE FUTURE

By KARL G. HARR, JR.
President, Aerospace Industries Association

The aerospace industry supports the Administration's efforts to cut government spending, fully understanding that the industry must share in the national belt-tightening involved. But there is one area of budget reduction that merits reconsideration—NASA's aeronautical research and technology program. Because NASA's technology development is important to U.S. competitiveness in sales of commercial aircraft—success in which means hundreds of thousands of domestic jobs over a protracted period—a second look at this program might show that the Administration's economic goals are better served by an increase in NASA aeronautical funding rather than a cut.

Among NASA's Congressionally-chartered missions is conducting research and developing technology toward "preservation of the role of the U.S. as a leader in aeronautical science and in the application thereof." This mission has never been more important than today, when American industry faces strong and growing competition from foreign aircraft producers.

NASA is finding it increasingly difficult to carry out its assignment of developing advanced technology to enhance the sales attractiveness of U.S. aircraft and thereby to benefit the national economy. Funding for aeronautical research is on the downhill slide. In the fiscal year just ended, funding was roughly the same it was 12 years ago—meaning that, when inflation is factored in, there was only half as much money available for research. Funding for the fiscal year just beginning is sharply below last year's.

For 60 years, NASA and its predecessor agency have been providing valuable assistance to U.S. aircraft manufacturers, particularly in commercial aircraft development. A current example is NASA's Aircraft Energy Efficiency program, which is producing a number of advances that offer significant reduction in fuel consumption at a time when fuel economy is a vital consideration in transport sales.

Industry, of course, conducts its own extensive research and development, at funding levels far greater than NASA's. But NASA plays an important complementary role. Industry cannot support all the promising areas of aeronautical research; business realities dictate that industry focus on projects which are clearly feasible and offer reasonable assurance of near-term payoff. It is essential to continued U.S. aeronautical leadership—and thus to the economy—that the government conduct supportive long-range research where the risk is great, the payoff too distant and the market uncertain.

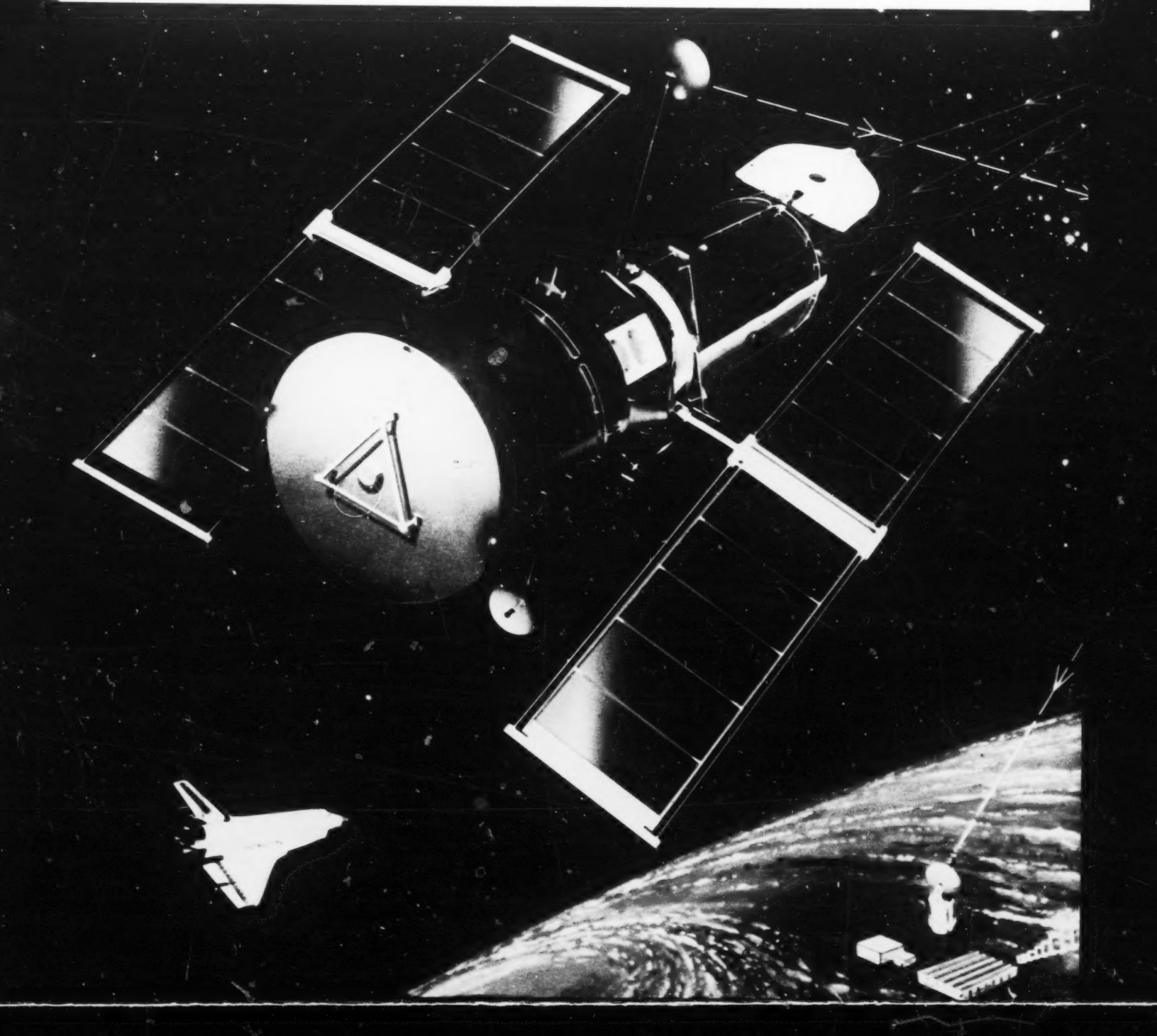
Our foreign competitors are getting such support. If American industry does not, a great amount of important research will not be conducted at all or, if accomplished, will yield results too slowly for competitive application. Either could have disastrous consequences for U.S. trade and employment.

The stakes are large. Last year, U.S. manufacturers produced transports valued at close to $10 billion, a level which supports some 700,000 direct and indirect jobs. With an estimated transport market of $120-130 billion in the coming decade, it is essential to our trade balance and job development that the U.S. maintain or increase its current share of the market.

If we are to meet the challenge from abroad, there must be a strong, adequately-funded research and technology effort in which government and industry work in balanced partnership. There is a clear need for a considerably expanded government support effort. Even if NASA's current funding for aeronautical research and technology were doubled, the increase would amount to less than 1/20th of one percent of the total federal budget. That seems a reasonable investment to maintain American leadership in aeronautics and to reap the economic benefits such leadership provides.

NASA SKY EYES: Orbiting Observatories

BY JAMES J. HAGGERTY



How big is the universe? The distances involved are beyond human comprehension. The mile is too puny a measurement; we must reckon in light years, the distance light travels in a year—about six *trillion* miles. The star nearest our Sun is more than four light years away. The Milky Way galaxy, of which our solar system is a tiny part, spans 100,000 light years. And there are hundreds of millions of galaxies in the observable universe.

Observable is a key word. Theory holds that there may be countless other galaxies, not observable because they are incalculably distant from Earth and moving away at the speed of light—thus their light cannot reach us. The observable universe, say those willing to estimate, stretches some 14 billion light years from Earth. But that's only an educated guess, because even the most powerful Earth-based telescopes can see only a small portion of the observable universe. A major limiting factor is Earth's veil of atmosphere, which filters out most of the light and other radiations coming from deep space, blurring our view of the cosmos.

That is why there is growing excitement in the scientific community about the developmental progress of NASA's premier space science project, the Space Telescope, which just passed a major milestone with completion of its primary mirror. The 12-ton observatory, to be Shuttle-launched in 1985, will operate above the atmosphere and thus provide an entirely new view of the universe.

Free of atmospheric distortion, and further enhanced by instruments that represent immense advances in astronomical technology, the Space Telescope will peer seven times farther into space than the largest ground-based tele-

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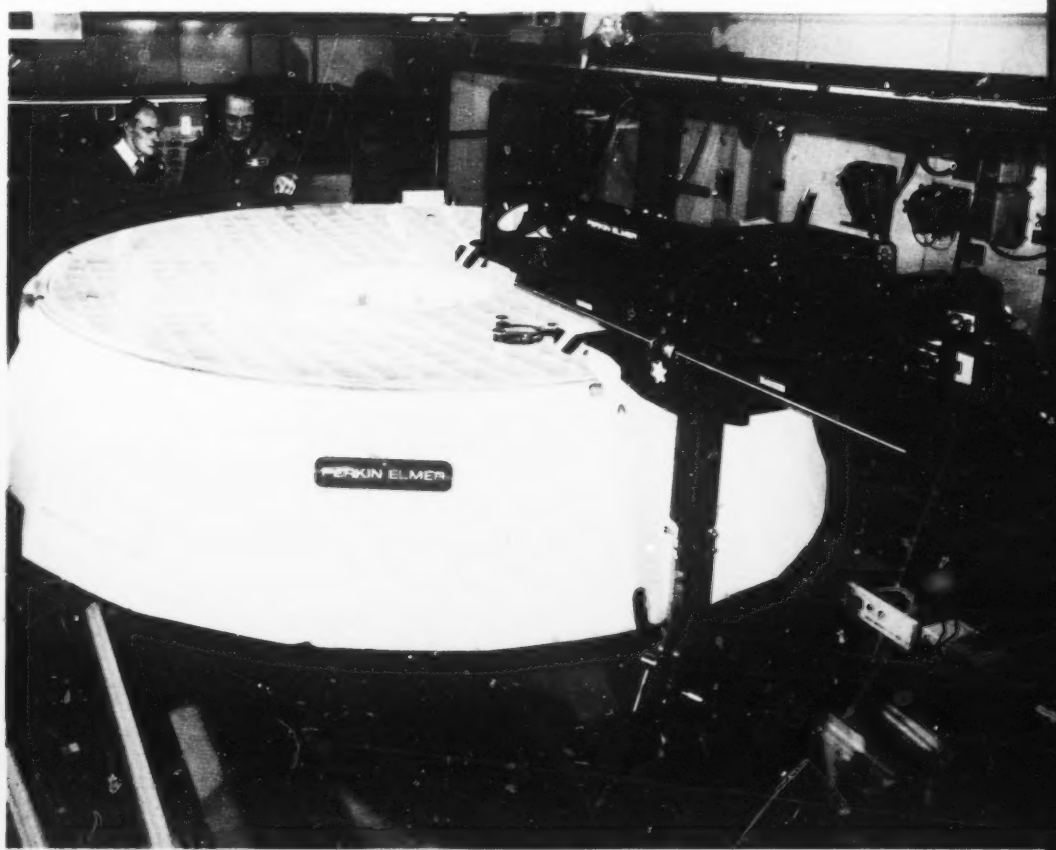

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1. Diagram shows how NASA's Space Telescope will work. Data and celestial images acquired by the unmanned spacecraft will be converted to electronic signals, sent to a data relay satellite, thence to Goddard Space Flight Center for computer processing. Goddard will forward the data and reconstructed images to astronomers at the nearby Space Science Telescope Institute.

2. Scientists at Perkin-Elmer Corporation conduct a quality control inspection of the Space Telescope's eight-foot-diameter primary mirror. Recently completed after four years of fabrication, grinding, polishing and coating, the mirror is the principal element of an optical system which will expand man's view of the universe 350 times.

scopes. It will expand our view of galactic space 350 times and may enable scientists to see to the very edge of the observable universe. Because light from distant galaxies takes so long to reach us, the Space Telescope will literally allow scientists to look back in time. Some of the light the telescope will capture was created before our own solar system existed and—a mind-boggling thought—we may be able to see the farthest galaxies as they appeared when the universe was formed 14 billion years ago.

Forty-three feet long and 14 feet in diameter, the Space Telescope will be by far the largest astronomical system ever sent into orbit. It is being jointly developed under NASA contract by Perkin-Elmer Corporation, a leading fabricator of scientific optical systems, and Lockheed Missiles & Space Company. Perkin-Elmer is producing the Optical Telescope Assembly, heart of the system, and Lockheed is building the Support Module, which houses the optics and the associated scientific instruments, and also provides electrical power, communications and data management. The European Space Agency will furnish one of the system's five major scientific instruments and the electricity-generating solar array. The spacecraft's development is being managed by NASA's Marshall Space Flight Center.

Although much smaller and lighter, the Space Telescope is similar in design and operation to the largest Earth-based telescopes, which literally "do it with mirrors." Starlight entering the open end of the telescope is reflected from a large primary mirror to a smaller secondary mirror, magnified and sharply focused, then directed to an instrument section for image photography and analysis. The Space Telescope has an eight-foot-diameter primary mirror and a one-foot secondary mirror. It took Perkin-Elmer more than two years, using computer-directed equipment, to grind and polish the primary mirror to the exquisitely-accurate surface fineness essential to the telescope's performance. The mirrors provide a degree of resolution—clearness of detail—10 times better than can be attained by Earth telescopes.

When the target star is very distant or very dim, the Space Telescope may have to point precisely at the target for as much as 24 hours; such long exposure is necessary to accumulate enough radiation to produce an image bright enough for analysis. The pointing requirement is roughly equivalent to a marksman in Boston zeroing in on a dime in Wahington, D.C. The job of keeping the telescope pointed falls to three "fine guidance sensors" which sense the telescope's position and measure the pointing error to within thousandths of a second of arc. The sensors convey their information to computerized equipment in the Support Systems Module which corrects the error. This capability for precise pointing over long periods of time will allow the Space Telescope to pick up objects 50 times fainter than can be seen by ground-based telescopes.

The Space Telescope is an unmanned spacecraft, but it is named in the sense that its operation will be controlled by scientists on the ground in two Maryland locations. Goddard Space Flight Center, Greenbelt, Maryland will manage the operational system, instructing the spacecraft as to target pointing and instrument work, and also continually monitoring the telescope's condition. Goddard scientists will be able to make corrections when necessary; they can, for example, transmit signals to the spacecraft's computer to fine-tune the alignment of the telescope's two mirrors.

Goddard will be electronically tied to the Space Science Telescope Institute, to be built on the campus of The Johns Hopkins University in nearby Baltimore. To be operated by a 16-university consortium known as AURA (Association of Universities for Research in Astronomy), the Institute will be the observation center where astronomers will view the images "seen" by the telescope and get visual and printed readouts of the data coming from the instrument module. They will, in effect, be operating in much the same manner as the scientific crews of ground-based telescopes, although at times their "eyepiece" will be thousands of miles distant as the spacecraft circles the Earth at an altitude of 370 miles.

The Space Telescope will observe mostly visible light, but it will also view infrared and ultraviolet radiations which are not visible to ground-based instruments. The images the telescope acquires will be instrument-analyzed, converted to electronic signals, and beamed to one of two NASA Tracking and Data Relay Satellites (TDRS), orbiting relay stations designed to handle the greater volume of space communications expected in the Shuttle era. The TDRS will transmit the signals to Goddard where the data will be computer-processed and the images reconstructed, then forwarded to the Space Science Telescope Institute.

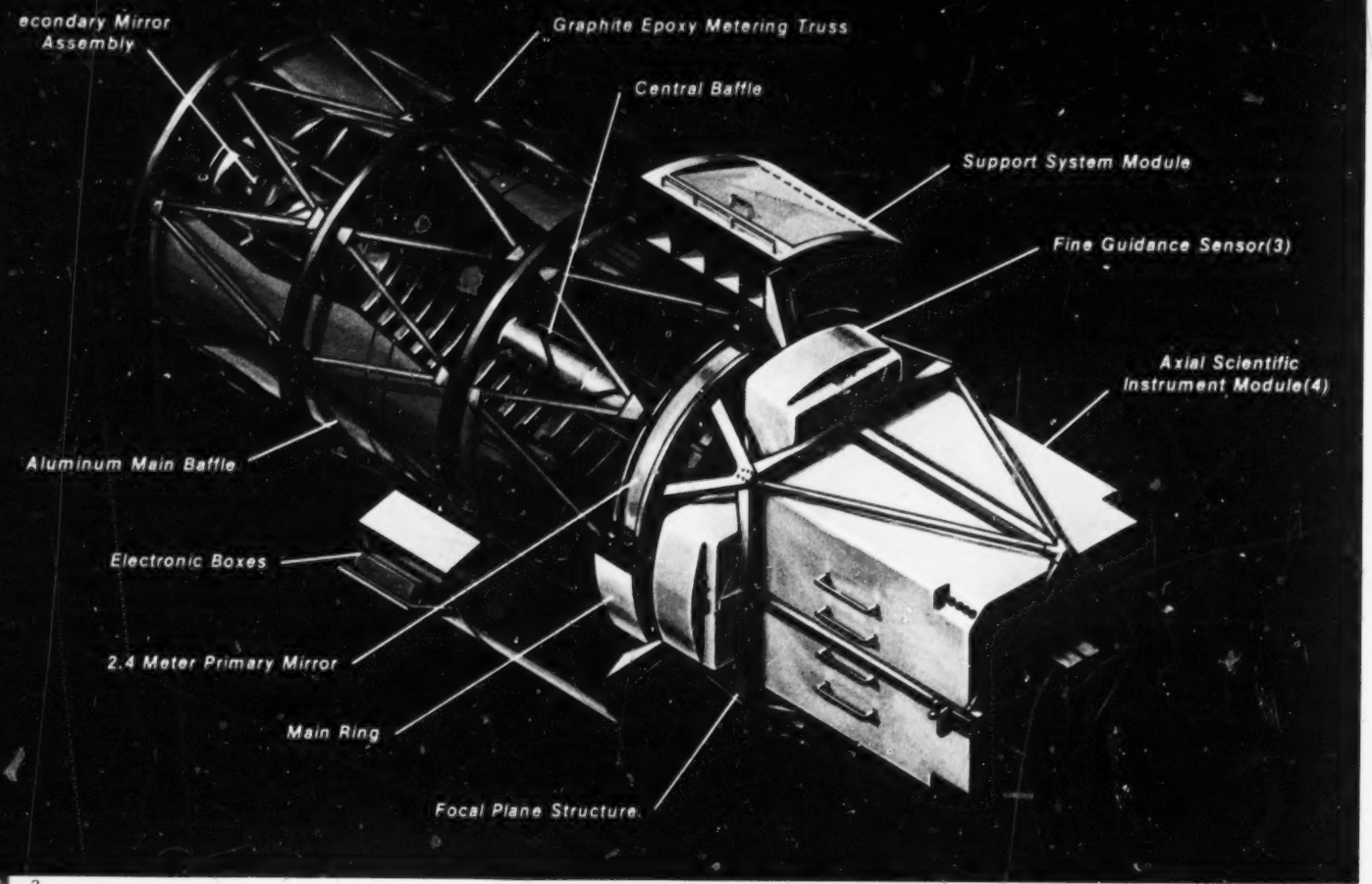
Among the initial complement of scientific instruments aboard the Space Telescope will be two cameras, one a wide-field system and the other a Faint Object Camera to photograph celestial objects so dim that it will take hours of exposure to produce an image. Other instruments include two spectrographs for analyzing the characteristics of radiations received and a high speed photometer for obtaining precise measurements of the radiations' intensity.

It is anticipated that, after a few years, these instruments will be replaced, because Space Telescope discoveries will undoubtedly require further investigation with more advanced or more spe-

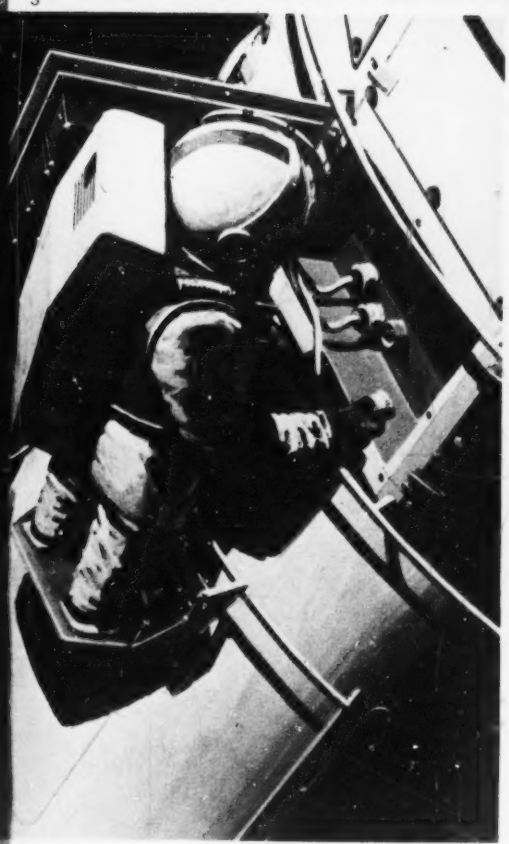
3. This cutaway view illustrates the operation of the Space Telescope. Light entering the open end strikes the primary mirror and is reflected forward to the smaller secondary mirror. Magnified and focused, the light is projected—through a hole in the primary mirror—to the focal plane. The resulting image is photographed and analyzed by scientific instruments in the module at right.

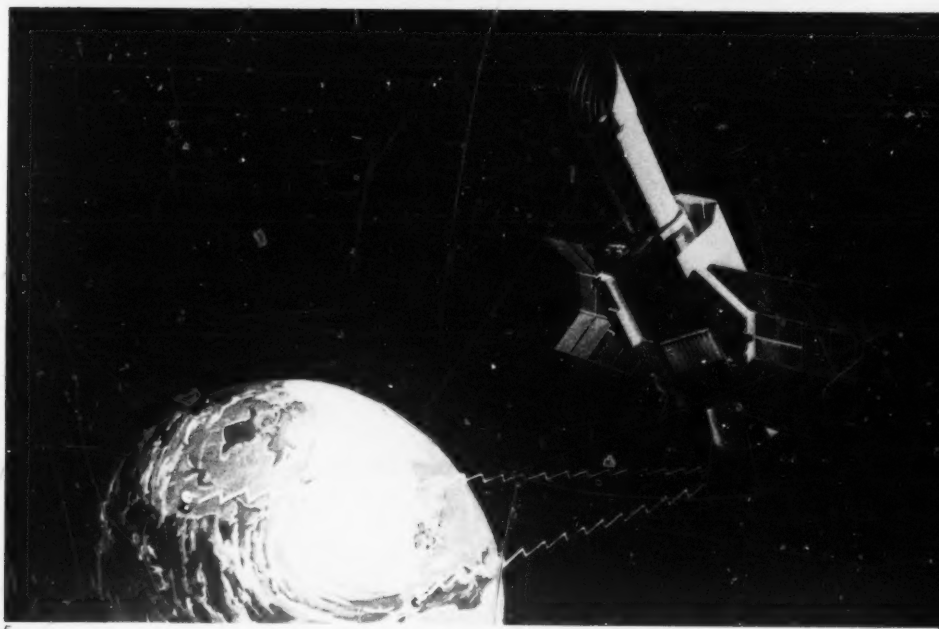
4. Space Telescope repair or instrument changes can be accomplished in orbit by extravehicular astronauts operating from the Space Shuttle Orbiter. This will extend the telescope's useful life to at least 15 years.

5. Already in orbit is the International Ultraviolet Explorer, first of an advanced family of orbiting astronomical systems which will complement Space Telescope findings by collecting radiations in parts of the spectrum not visible to ground telescopes.


econdary Mirror Assembly
Graphite Epoxy Metering Truss
Central Baffle
Support System Module
Fine Guidance Sensor(3)
Axial Scientific Instrument Module(4)
Aluminum Main Baffle
Electronic Boxes
2.4 Meter Primary Mirror
Main Ring
Focal Plane Structure

3





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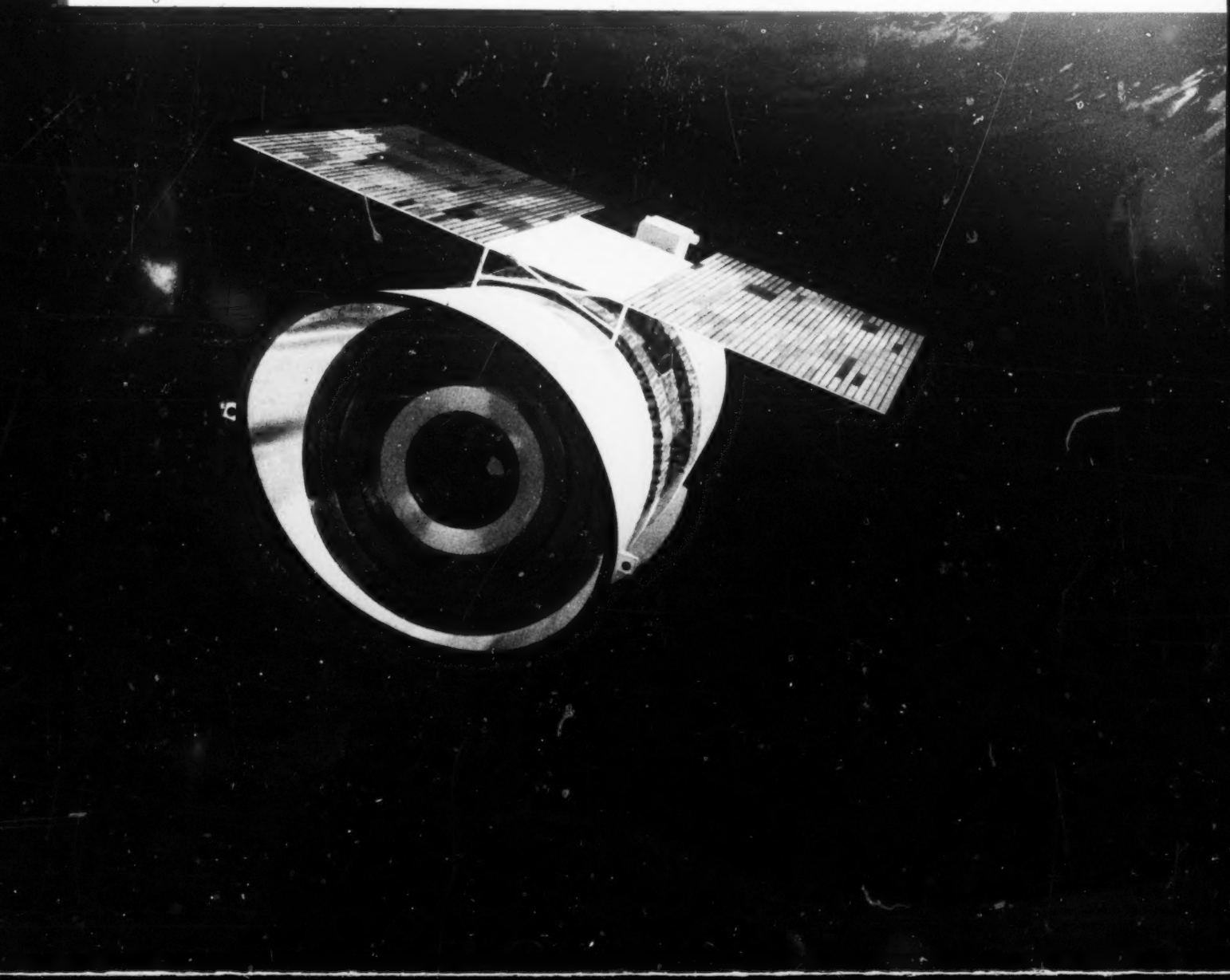
cialized instruments. When replacement becomes necessary—or when some element of the spacecraft needs repair—the Space Shuttle Orbiter will rendezvous with the Space Telescope, retrieve it and mount it in the Orbiter's cargo bay, where extravehicular astronauts will make the required changes. If extensive maintenance is needed, the Orbiter will return the telescope to Earth for refurbishing, then re-deliver it to space. Its useful life thus extended, the Space Telescope is expected to be in service for at least 15 years.

Last June, Perkin-Elmer finished polishing the primary mirror, shaping its surface to less than a millionth of an inch from mathematical perfection. A final touch, recently accomplished, involved application in a vacuum chamber of two infinitesimally thin vaporized metal coatings, one of pure aluminum to enhance reflectivity, one of magnesium flouride to protect the surface. Next, Perkin-Elmer will install and align the various elements of the Optical Telescope Assembly—mirrors, imaging plane, scientific instruments and fine guidance sensors. Finally, the telescope assembly will be integrated with Lockheed's Support Systems Module. The completed spacecraft will then be exhaustively ground-tested preparatory to its early 1985 delivery to orbit.

The Space Telescope is the centerpiece of a new thrust in extraterrestrial research that has already begun and will continue into the 21st century. Over the past decade, NASA has operated a number of relatively small astronomical satellites which have provided a wealth of knowledge and a broad base for more advanced exploration. NASA is now expanding cosmic research with a new family of much larger and far more capable space astronomical systems. Backing up the Space Telescope is a series of orbiting observatories, planned or in active development, which will return complementary data. Where the Space Telescope will view visible light for the most part, these other spacecraft will specialize in collecting and analyzing radiations in other parts of the spectrum which, normally absorbed or filtered by Earth's atmosphere, are largely invisible to ground telescopes.



Already in orbit is the International Ultraviolet Explorer (IUE), a joint NASA-European Space Agency-United Kingdom project. The IUE has a relatively small—17½ inch diameter—telescope which collects ultraviolet radiation for study of the energy generated by many different types of celestial objects. Goddard Space Flight Center designed and integrated the spacecraft.

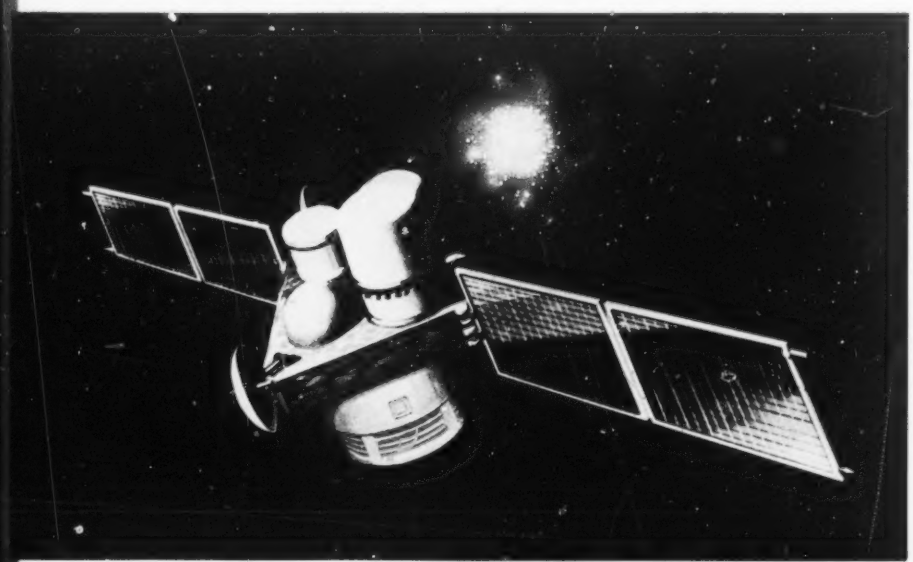
Next in space is the Infrared Astronomical Satellite (IRAS), to be launched in 1982. NASA's Ames Research Center is providing a 24-inch telescope with unprecendented sensitivity to infrared radiation; The Netherlands is building the spacecraft and the United Kingdom will operate the control center. The infrared region IRAS will investigate is one of the least explored areas of the spectrum. The observatory will enable study of some stars in death throes and others being born; it will conduct a systematic sky survey, mapping a million infrared sources for future study. Jet Propulsion Laboratory is NASA's project manager.

Scheduled for repetitive service beginning in 1987 is the Solar Optical Telescope. Mounted in the Shuttle Orbiter's cargo bay, the four-inch-diameter telescope will provide several hundred Sun images on each flight, amplifying the work of earlier solar observatories by concentrating on detailed examination of certain solar phenomena not yet well understood. NASA's Office of Space Science is managing the program.

NASA plans a 1988 launch of the Gamma Ray Observatory (GRO), a large spacecraft approaching the size of the Space Telescope. Gamma rays are the most energetic form of radiation known; study of how they are produced and where they come from is expected to advance significantly man's knowledge of cosmic energy processes and the evolution of the universe. Goddard Space Flight Center is project manager; TRW, Inc. is working on a design contract.

A project recently initiated is NASA's Advanced X-ray Observatory, another king-size spacecraft of approximately Space Telescope dimensions. Planned for 1989 launch, the observatory is a follow-on to the recently retired, TRW-built HEAO-2 (High Energy Astronomy Observatory). It will be cabable of detecting X-ray sources 50 to 100 times weaker than its predecessor and it is expected, like the Space Telescope, to peer as far as the edge of the observable universe. Marshall Space Flight Center, NASA's project manager, is studying proposals and contracts for development of X-ray detecting mirrors will be awarded soon.

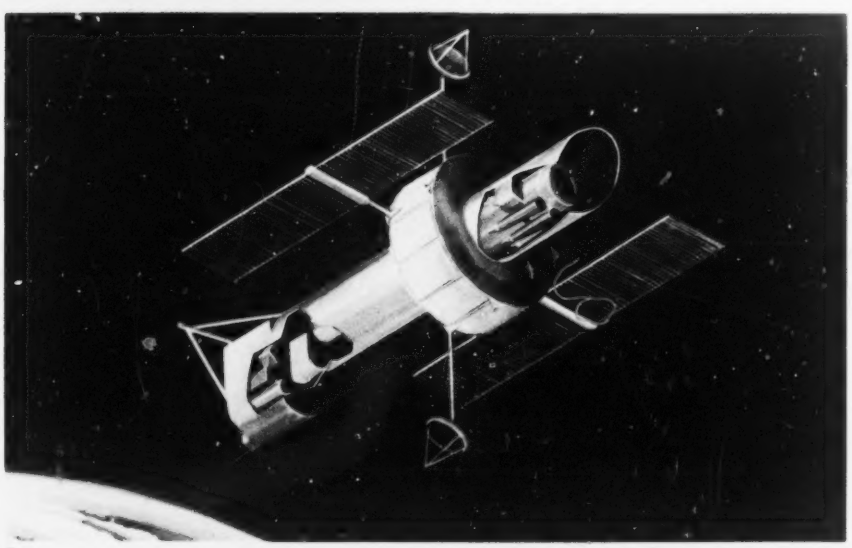
It is probably understatement to say the Space Telescope and its teammate spacecraft will change our concepts of the cosmos. They are likely to generate more knowledge about the universe, its origin, evolution and energy processes than has been accumulated in all the years since the 17th century invention of the telescope. It is knowledge of incalculable value, because in fitting together the cosmic mosaic, scientists will learn more and more about the star we call Sun, its planets and the complex processes that govern Earth—to the point, perhaps, where future mankind can manage these processes in enormously advantageous ways we can't now begin to envision.



6. To be launched next year, the Infrared Astronomical Satellite will map a million infrared sources in the universe for future study.

7. Planned for 1988 launch, the Gamma Ray Observatory will study how gamma rays are produced and where they come from, an important area of research about which little information exists.

8. Targeted for service in 1989, the Advanced X-ray Observatory will detect celestial X-ray sources 50 to 100 times weaker than earlier spacecraft have detected.



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THE U.S. AIR FORCE: MEETING THE SOVIET THREAT

I would like to divide my discussion into three areas. First, some thoughts about the Soviet threat. Second, a brief discussion of some of our weapons. And third, and by far the most important of all, some observations on Air Force personnel.

With respect to the Soviet threat, it was not too long ago that a United States citizen made headlines by suggesting that this country cut armaments 50 percent, with the expectation that the Soviets would then do likewise.

The proposer of that suggestion was undoubtedly sincere, but I have to believe that he was naive. In plain truth, we have been maintaining a level of expenditure on armaments at less than 50 percent of the Soviets for at least the past four years—and it hasn't worked! It has been said that when we build they build, when we stop building, they build.

Consider, for example, the rate of production of fighter planes. In Fiscal Year 1982, if the budget goes through Congress as we hope and expect it will, the Air Force will purchase 222 combat planes. If we add roughly a comparable number for the Navy, we come out at something less than 500 for the two services. The Soviets will build 1300 in this same time frame. The Air Force hopes, over the next five years, to add 12 combat squadrons. At the current rate of Soviet production, disregarding attrition, they will be equipping a new combat squadron every week or so.

Since 1960, the Soviets have increased the number of intercontinental delivery vehicles sixfold with the result that our former nuclear superiority is gone. Even more important is that this change in the strategic balance enhances the Soviet perception of their ability to achieve their objectives in a nuclear war.

The Navy Secretary and the Army Secretary could tell their own stories about excessive Soviet production in ships, in submarines, in tanks, trucks, and field artillery. The fact is that we are being massively out-built by the Soviet Union in almost any area that it takes to wage war.

Even in space, the Soviets have continued to forge ahead rapidly. We take justifiable pride in the successful flight of the Space Shuttle, but let us not overlook that Young and Crippen were the first Americans in space in six years. During that same interval, the Soviets launched 20 two-man space missions and one three-man mission, a total of 43 men in space.

We hear a great deal about defense budgets. Let's put the discussion in historic perspective. The truth is that current defense spending is not high by historical standards. Under President Eisenhower, for example, defense was 10-11 percent of GNP and under President Kennedy, prior to Vietnam, it was 8 percent. Projected defense budgets over the next few years do not exceed 7 percent of the GNP, less than either Eisenhower or Kennedy. I think the question should not be can we afford the Reagan budget for defense? The question should be can we not afford the Reagan budget for defense.

The present superiority of the Soviet Union encourages them to undertake the type of aggression witnessed in Afghanistan. They must understand that they cannot destroy us with the first strike; that our surviving forces will remain responsive under the National Command Authority; and that we are capable of denying Soviet aims. As Secretary Weinberger pointed out a few months ago, "We must be prepared to meet Soviet military power, however it might

Myth Number One: military planes are so complex pilots can't fly them safely. Fact: the McDonnell Douglas F-15 has an accident rate less than half that of the predecessor F-4 at the same stage of development.

By THE HONORABLE VERNE ORR
Secretary of the Air Force

be used. We have to be stronger than we were before because the Soviets are stronger. Otherwise we will not be able to deter the conflict we all want to avoid. And if deterrence does fail, we must be able to win to survive."

Let me discuss Air Force weapons.

Every so often someone writes a book or a magazine article and earns himself a tidy sum of money by arguing that our weapons systems are overly complex.

These articles have usually two themes —I would prefer to call them myths. The first is that our planes are so complex that we are unable to train pilots to fly them safely. The second is that our planes are too complex to maintain with the result that they are always down for repair.

A long time ago I was the editor of our college daily. I learned then that the best column or editorial can be ruined by a search for the facts. By the same token, some of our critics would have their arguments destroyed if they were more careful to search out the facts. What are those facts?

The F-16 currently has an accident rate of 13 aircraft destroyed per 100,000 flying hours. Compare that with some of the less complex planes that are supposedly safer.

The F-100, at the same stage of its development, had a record of 40 aircraft destroyed per 100,000 hours of flight. The F-104 had a record of nearly 60 aircraft destroyed per 100,000 hours of flight and if you want to go way back to the P-51, as some of our critics have yearned to do, it had a record in one year of 111 aircraft mishaps for each 100,000 hours of flight, a record significantly greater than the current F-16.

And if the F-16 is so unsafe and so difficult to maintain, can you tell me why the Israelis were so upset when their delivery of F-16s was delayed a few weeks or why Venezuela and Pakistan are knocking at our door to get earlier delivery of these same planes?

If one looks at twin-engine planes, the F-15 has an accident rate of less than five destroyed aricraft per 100,000 flying hours. At the same stage of development, that accident rate his less than half the F-4's.

How about the other half of that great myth, that our planes are so complex they are constantly under repair.

In 1980, the F-16 had the third lowest maintenance manhours per hour of flight of our six USAF first-line fighters and bombers.

Let me dwell briefly on the trend in warfare. In World War I, we all know that the battleships fought in such places as Jutland when they could just see each other on the horizon. Twenty-five years later, in World War II, battle groups seldom came in sight of each other. Instead, the conflict was carried on at several hundred miles distance by carrier planes launched from both sides.

Since World War II, we have had conflicts in areas of the world where modern weapons and tactics are employed. If one studies the reports of Israeli and Syrian aerial engagements, for example, one quickly sees that planes are being shot down even before the pilots come into visual contact.

It is against this trend of increasingly more technologically sophisticated warfare that we hear of those who would have us build simple, inexpensive weapons. Just what capability would they prefer that we omit? The radars, which enable a pilot to know he has an opponent? The missiles, which enable him to fire a weapon that will seek out his opponent? The anti-jamming devices, which are designed to negate the radar from ground-based antiaircraft? The sensing devices on our planes, which let a pilot know that a missile has been fired at him and permit him to take evasive action? The supersonic speed, which offers the pilot some chance of quick evasive action when he is fired upon? No, the critics never answer the hard questions.

Let me assure you of one thing. This Administration did not come to Washington to lead in the sacrifice of American youth upon the false altar of inadequate, inferior planes. I promise you we will continue to build sophisticated, capa-

Myth Number Two: the new aircraft are so complex to maintain they are always down for repair. Fact: the General Dynamics F-16 has the third best maintenance man-hours record among first line USAF fighters and bombers.

ble weapons systems which will enable our pilots to fly with the least loss of life possible.

That does not mean that this Administration is not interested in economies in the Air Force.

No one can operate a service with over 560,000 uniformed personnel, 240,000 civilians and about 200,000 in the Guard and Reserve—a total of approximately a million—and say that there aren't economies and efficiencies to be achieved.

We are looking for them in big ways and in little ways. Let me give you just two illustrations. When I became Secretary, I asked the Assistant Secretaries, the Deputy Assistant Secretaries and the "blue suit" offices to take a hard look at their magazine and newspaper subscriptions. We cancelled 86, a total of 20 percent of all those arriving at the Pentagon.

A small savings, but they add up.

Recently, I conferred an honor on a member of the Air Force who suggested that planes at the Air Training Command receive air pressure and electricity through a centralized distribution system rather than from individual units located next to each plane. The life time savings at that one command? Seventy-five million dollars. A big savings.

Large and small, we are seeking economies.

Finally, and most important, I want to discuss Air Force people. We can have the best planes and the most accurate missiles that the world has ever seen but if we don't have dedicated, competent personnel to man them, to see that they are in a good state of repair, and to see that the necessary parts are there when needed, then we will not have an effective Air Force.

I am told by those that have been in the Air Force a long time that morale is considerably higher than is has been for some time.

A substantial part of that high morale must be attributed to the pay raise of last year, and for that we extend our thanks to Congress and the previous Administration. Another very important part is undoubtedly due to the fact that military personnel will get a pay raise effective October 1st. However, if we get approximately 14 percent, that will merely bring our personnel up to the level we promised when we began our transition to the All-Volunteer Force in 1972. At that time, we agreed that personnel should earn roughly what they could doing similar work outside the military. (Note: Congress passed the pay raise at press time).

There has been some talk that the All-Volunteer Force is a failure; that we cannot recruit adequate quantities of qualified people. This Administration thinks that, until we meet our targeted goal of paying equivalent wages, it is premature to discuss whether or not the All-Volunteer Force is a failure. We are confident that, with adequate pay, good housing, and acceptable working conditions, the All-Volunteer Force can be successful.

On that score, let me tell you that our efforts in recruiting are moving forward splendidly. For the fiscal year just ending, the Air Training Command set a target that 88 percent of the recruits with no prior military experience should be high school graduates, and I am pleased to tell you that the target was achieved. For the coming fiscal year they have increased the target to 92 percent and are confident that it will be met.

Beyond achieving our general recruiting goals, I should comment that the Air Force continues to be the leader among the governmental agencies and the military services in the recruitment and utilization of women. Our 63,000 women—a 400 percent increase since FY 72 and at 11.2 percent, the highest female representation in any service—are an integral part of our Air Force capability. We are proud that the Air Force has equal enlistment standards for both men and women and includes the largest number of women officers of any military service.

In brief, our recruitment programs have been aggressive but realistic; they have produced results. Our morale is good—our people are trained—they are ready. However, permit me to sound a note of caution. Some—possibly a very large amount—of the high morale of our people is based upon the expectation that this Administration will recognize their needs and will react accordingly. If we fail to convince the Congress that a substantial pay raise is in order, much of that aura of good feeling could rapidly disappear and the gains of the past year lost. Along these same lines, the current pay cap has caused a degradation in the pay of our general officers by as much as 15 percent per year. This pay cap impresses me as one of the most shortsighted policies that this country could adopt. Assuming a cost of living raise is approved as planned, all general officers will make the same amount, and in slightly over a year, it is likely that a full colonel will receive the same salary as the Chairman of the Joint Chiefs of Staff. The real squeeze comes among two-star generals who, in the prime of life, possessing a wealth of experience, are just the type person being sought by corporations for their executive leadership positions. The prospect of earning no more for the next eight or 10 years, combined with the necessity to change residences several times during that period at an out-of-pocket cost, and the removal of a number of perquisites which formerly were enjoyed by general officers, combine to encourage many of them to leave the service. If we are to have strong leadership in the Air Force, this type of policy must be changed, for it deprives us of the high-quality people that are the foundation upon which such leadership must be built.

Certainly one of the prime factors in producing a competent All-Volunteer Force is the respect that the citizens of this country pay to personnel who have chosen a military life for a career. My officers tell me that today they wear their uniforms to events and places where they would not have considered being in uniform only a few years earlier. There is a new spirit in this country regarding military service, a return to a spirit that once existed.

It is really the view that the citizens hold toward the military and defense that is crucial. If we are to meet the Soviet threat that I described earlier, we need a working relationship—a partnership—wherein we in the Air Force provide the means to assure our nation's security and those not in the military keep us on guard—alert to those areas where we can do this more efficiently.

Within this partnership, what can the citizens expect from the Air Force? They can expect confident, loyal, trained personnel and outstanding weapon systems procurred at the least possible cost. They have a right to expect that the public's money will be well spent for a strong Air Force.

Within this partnership what can we count on from the citizens? First, that they will carry the message throughout the United States concerning the threat that this nation faces. Second, that they will work with us to eliminate waste. Third, we ask that they strive to increase public appreciation of those who devote their lives to this nation's defense.

Together we must ensure that the United States has policies that are stable, offers a viewpoint that is respected, is a nation whose friendship is sought and has the determination and the ability to keep the peace. In partnership we can do it.

Born in Des Moines, Iowa, Verne Orr is a longtime resident of California, where he was engaged in automobile, investment and real estate businesses. A World War II Navy officer, he later served in several posts with the California state government. From 1975 to 1980, he taught government finance courses at the University of Southern California Graduate School of Public Administration, and in February 1981 he assumed his duties as Secretary of the Air Force. The foregoing article is based on Secretary Orr's remarks to the 1981 Air Force Association annual convention.

THE PROPELLER'S COMEBACK

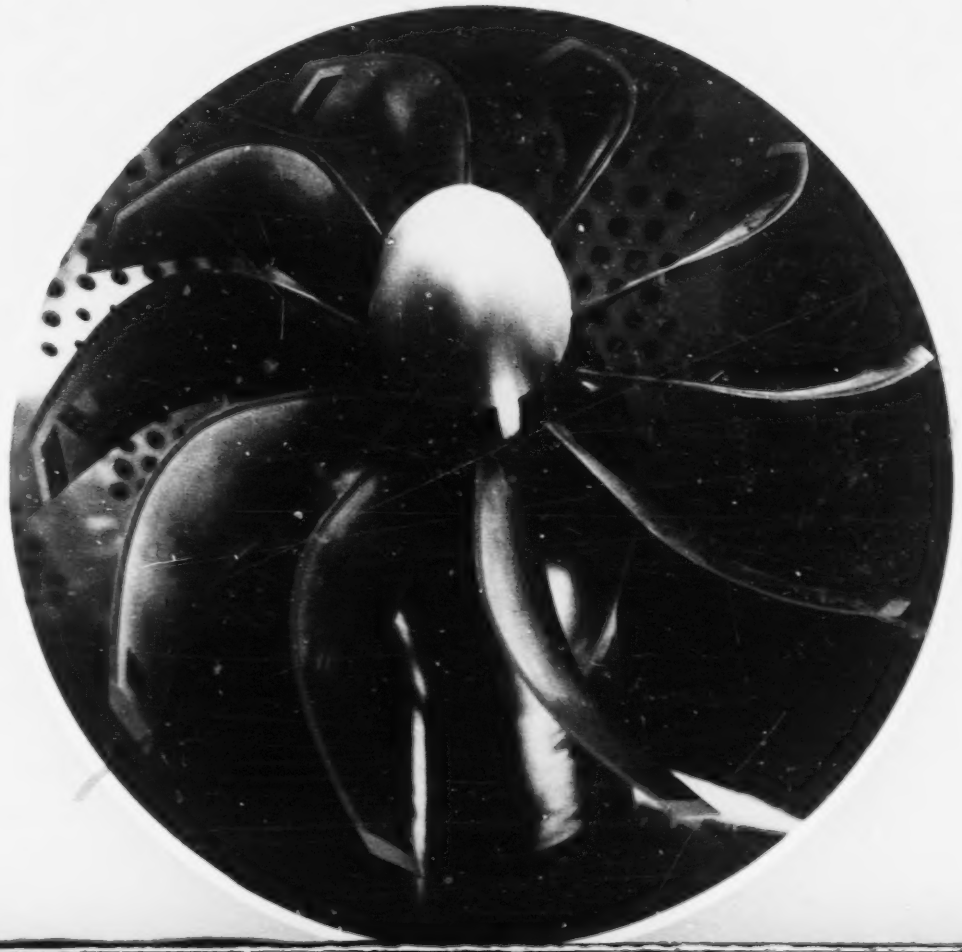
Rising fuel costs spur advanced research toward turboprop aircraft for the 1990s

Speed is the name of the game in military and commercial aviation. That's why the propeller-driven airplane has been in decline since World War II. The propeller could not provide the kind of thrust needed for combat aircraft operations, nor could it match the jet engine's ability to drive airliners at high subsonic speed.

But the propeller is experiencing reawakened interest, at least as a research target. The reason is that the turbine-driven propeller has inherently better fuel consumption than the jet or turbofan engine. That was a negligible factor in the days before the OPEC oil price rampage, when fuel cost 10 to 12 cents a gallon. Now the price is approaching $1.50 a gallon and surveys indicate it may double within the decade. Rising fuel cost is the biggest single problem confronting the financially-harried airlines, who might be persuaded to take a new look at the propeller—if it could provide the measure of speed and comfort to which jetliner passengers have become accustomed.

It can, a number of researchers feel.

This is a wind tunnel model of Hamilton Standard's "propfan," whose advanced technology blades promise jetlike aircraft speeds at sharply reduced fuel consumption.



A Lockheed-Georgia concept of a military tactical airlifter powered by advanced turboprop engines.

For several years, NASA and several aerospace companies have been studying advanced propeller systems in wind tunnel and limited flight tests. Preliminary results are encouraging.

"Propellers appear ready to make a big comeback," says William E. Arndt, manager of Lockheed-Georgia Company's Propulsion and Acoustics Department. "By 1990, the airlines may be routinely flying passengers across the country in a new type of propeller-driven aircraft. Unlike the turboprop aircraft designed in the 1950s, such as the Lockheed Hercules and Electra, the new aircraft will have advanced technology propellers that will allow cruise speeds and levels of cabin comfort comparable with modern turbofan 'jet' aircraft. More importantly, these innovative aircraft show promise of 15-20 percent savings in fuel consumption."

That's a lot of savings when you consider that the airlines burned almost 11 billion gallons of fuel last year.

Of course, tomorrow's airplanes will consume less fuel whether they are turboprop or turbofan-powered. The new family of jetliners, exemplified by the recently-flown Boeing 767, are significantly less fuel-thirsty than their in-service counterparts. Later aircraft will further benefit from extensive research, being conducted by NASA and industry, which attacks several facets of the problem.

Researchers are investigating engines operating at higher temperatures and pressures, which means greater fuel efficiency; improved aerodynamics for reduced air resistance; use of lightweight composite materials in aircraft structures, cutting aircraft weight and saving fuel by easing engine workload; smoothing turbulent airflow to reduce fuel-wasting air drag; and computerized electronic flight controls which assure precise load distribution, allowing design of lighter structures. All of these improvements, which collectively could cut fuel consumption in half, are applicable to either turboprop or turbofan aircraft—but the turboprop would still have an additional edge.

The principal reason for the decline of the turboprop in the jet age was the limitation of propeller tip speed. Just as the straightwing airplane encountered a sharp drag increase at high speed, the propeller similarly met excessive drag as blade tip speed approached the speed of sound. So propeller-driven transports were limited to cruise speeds on the order of 400 miles an hour—not good enough to compete with the jetliner, despite the turboprop's better fuel consumption, because fuel cost was not then an issue.

When it became an issue in 1973, NASA sponsored industry studies of near-term solutions for sharply escalating fuel costs. One outcome was the conclusion that the propeller offered more dramatic fuel savings than improvements to the turbofan engine—if the propeller could be made to operate efficiently above Mach 0.75, or an airplane speed of 520 miles per hour.

Hamilton Standard Division of United Technologies, a leader in the propeller revival, came up with a proposal for a "propfan" incorporating a number of advanced technologies. The company took a design approach similar to that employed in the wing of a high-speed transport, which is thin and swept back to delay drag rise. Applied to the propfan blade, the thin profile and sweepback of the blades combine to increase efficiency and reduce community noise. Instead of designing larger diameter propellers to absorb the higher power required, HamStan opted for a system

These views show the McDonnell Douglas DC-9 as it would look with wing-mounted or aft-mounted propfan engines.

of eight to 10 swept blades operating at supersonic tip speed.

Tests in wind tunnels demonstrated efficiencies close to the goal of 80 percent. This means that propfans installed on high speed transports are projected to have propulsive efficiency 20 percent better than a turbofan at speeds of about 550 miles per hour. If an operator is willing to settle for 500 miles per hour, the fuel consumption improvement would be even better.

But so far testing has been limited to small-scale propfan models. The promise of the new turboprop must be validated by further ground research and by flight tests of a full-scale propfan on a testbed airplane.

NASA plans to do that in its Advanced Turboprop Program, which contemplates initial testbed flight about year-end 1985. In addition to Hamilton Standard, major industry participants in the program are Lockheed-Georgia Company and Douglas Aircraft Company. A leading candidate for the propeller-drive system is a Detroit Diesel Allison turboshaft engine. Candidate testbed aircraft include the Lockheed C-141 and Boeing KC-135 military jet transports, the McDonnell Douglas DC-9, the Convair 990 and the Grumman Gulfstream II executive transport.

Before the propfan can become a serious contender for airline application, there are other problems that must be solved. Noise, for example. Although early indications are that community noise from a propfan aircraft would be lower than that of a turbofan-powered transport, cabin noise would be higher. Researchers are considering several approaches to that problem, including "acoustic treatment," or noise-insulating the passenger cabin, if that can be accomplished without a significant weight penalty that would wipe out much of the fuel efficiency gain. Other approaches include advanced propeller synchronizing techniques or mounting engines farther from the cabin wall—aft of the cabin or farther outboard on the wing.

Two other problems remain to be resolved. Can a large-scale propfan be built light enough yet stiff enough to sustain the loads of high speed flight? And can the turboprop, traditionally used on straight-wing aircraft, be installed on a high-speed swept-wing airframe without loss of aerodynamic efficiency?

If further research and testbed flights answer these questions affirmatively, the propfan aircraft could be available for operational service by 1990. It is unlikely that there will be a sudden shift to turboprops across the board, but the advanced propeller system could make initial inroads in aircraft categories for which it is particularly well suited—for example, 80 to 160-passenger short-haul airliners which spend most of their time climbing and descending and rarely reach altitudes at which the turbofan engine is most efficient. Other possibilities include intratheater military transports and business aircraft.

Along with the technical considerations, there is one other question: the psychological factor. Will passengers, many of whom have never flown in a propeller-driven plane, be willing to accept what would appear to be a technological retrogression? The answer to that may lie in the future pattern of fuel costs. It is not inconceivable that a new oil price escalation could send fuel prices even beyond the $3.00 a gallon projected for 1990. If that happens, necessity may mother the innovation from the airline standpoint and passengers may more readily accept the propeller once they understand that it is an alternative to sharply increased fares.

THE BUSINESS AVIATION

In this article, based on recent Congressional testimony, the head of the leading business jet manufacturing company discusses the problems confronting business aviation and recommends some actions that could enhance U.S. industry's ability to compete more effectively in the world marketplace.

Although the business jet segment of the general aviation industry has enjoyed steady growth over the past few years, there is at this time an aura of uneasiness about the future vitality of the market. Considerable uncertainty pervades our corporate and industry planning. There are a number of negative factors in today's general aviation equation that tend to dampen our industry's optimism, among them:

- High interest rates, a serious deterrent to capital investment.
- Rising costs of materials and labor.
- Compliance with government regulation.
- Proposed increases in fuel taxes that are both discriminatory and grossly inequitable.
- Significant increases in foreign competition and unfair trade actions in which our government takes no interest and no reciprocal action.
- Cuts in airport aid, even though a huge user fund exists for expanding system capacity.

Government Support of Civil Aviation

In considering how the government might assist our industry without adversely affecting healthy competition, let me begin with a basic premise: in our society, the least government is the best government.

The preeminent position that U.S. aircraft manufacturers enjoy is the world today came about because of the willingness of industry leaders to risk capital investment in research and development, to put together a marketing system extolling the virtues of their respective products, and then set about convincing potential buyers of their individual product's economic benefits. That's what our company did—and the driving force has been competition.

In our highly competitive marketplace, fuel efficiency, performance utility, after-sale support, and acquisition and operating costs are the prime considerations influencing the decision of prospective customers.

There is no government role in the customer's decision to buy or not to buy—and that is as it should be. But over the past few years the old adage that success breeds contempt has become somewhat of a truism in our industry, insofar as government policies are concerned. Even now we are facing a proposal to increase fuel taxes. If it is enacted, the resulting increase in operating costs would severely impact potential sales.

Currently the market for many sales and models of U.S. general aviation aircraft is depressed. Our own company backlog now stands at $1 billion, but the market for business jets has softened since the first of the year and 1981 orders have fallen short of our original projections. Uncertainty has set in and with it "buy" decisions are being delayed. Yet customer interest remains high, indicating to us that the implementation of President Reagan's economic recovery program could make a difference. The degree to which U.S. business values the prospects of the President's program will dictate the near-term results.

In our view, renewed vitality in the business aviation marketplace will largely depend upon these conditions:

- A healthy and vigorous U.S. domestic economy capable of generating sufficient new aircraft orders at cost-competitive prices.
- Industry's ability to maintain a strong marketing and sales support program.
- Availability of suitable financing and credit terms that are competitive worldwide.
- A fair world trade environment under which U.S. manufacturers will have equal opportunities in international markets.
- Joint efforts by industry and government to again develop and maintain a superior technology base.

Comparing Aeronautical Capabilities

The current true state of our aeronautical capabilities compared to foreign competition continues to be a subject of considerable debate. But on one very fundamental point most authorities are in total agreement: in recent years U.S. research and development efforts have lagged behind those of other nations.

Senator John Glenn of Ohio cited some statistics that clearly show a most disturbing trend in our national commitment to R&D. In the 12-year period, 1958 to 1980, for example, the United States R&D as a fraction of the Gross National Product decreased 19 percent, while in

MARKET

Gates Learjet's Longhorn 55 incorporates the NASA-conceived area rule shape and thrust-enhancing winglets to improve fuel efficiency, examples of NASA technological assistance to manufacturers of civil aircraft.

the Soviet Union it actually increased by 14 percent, in West Germany by 16 percent, and in Japan by 19 percent.

These numbers take on added economic significance when it is recognized that approximately 40 percent of all U.S. R&D is defense-related. But only about two percent of Japan's and eight percent of West Germany's R&D are being spent on military projects and programs.

Even more alarming is the fact that during this 12-year period basic research as a fraction of the federal budget decreased 27 percent and R&D 36 percent. At the same time, the investment by industry in basic research as a fraction of net sales declined 32 percent. And this occurred while much of America's industrial research was being directed toward meeting regulatory and environmental requirements.

It is well documented that research and development and technological innovation play a significant role in our nation's economic progress. According to studies on U.S. productivity by economist Edward Denison, from 1929 to 1969 about one-third of our nation's growth was attributable to "advances in knowledge." Yet between 1949 and 1969, this factor accounted for some 48 percent of our growth—making it an even greater contributor than inputs of capital for that time period.

The contribution of R&D to economic growth and productivity, therefore, is positive and extensive. But unless the present trend is reversed, the U.S. will be less of a factor in world markets. And declining economic power could result in declining political influence abroad as well.

The true state of our aeronautical capabilities today is that the U.S. aircraft manufacturing industry is, indeed, well ahead of the rest of the world. American ingenuity has put together the most efficient combination of metallurgy and petroleum that man has ever devised—we call it an airplane. That's why we are able to sell American-built aircraft in every country where freedom of movement prevails. Our products simply outperform the competition.

But the circumstances are changing. The signs are all about us. Dr. Richard Whitcomb,the distinguished aerodynamicist of the National Aeronautics and Space Administration, recently reflected that the traditional technological "spinoff" roles appear to be reversing themselves. Business jet aircraft, for so many years the benefactors of technologies created by others, are now becoming the prime sources of significant innovation. Our company, as an example, was the first commercial manufacturer to adapt for civil production aircraft the area rule shape and new thrust-enhancing winglets, both conceived by Dr. Whitcomb and his NASA associates. These developments have been incorporated in Learjet designs in order to help achieve our goal of flying higher and faster with the optimum fuel efficiency.

However, it would now appear that the business aircraft industry has reached a reasonable state-of-the-art where technological advances, up to the year 2000, at least, will be largely devoted to refinements in fuel efficiencies, greater cabin comfort, improved cockpit displays and the like. As is generally the case in the evolution of technical progress, quantum leaps are infrequent. I believe the time has come for another quantum leap, especially with respect to new composites, more miniaturization and other design innovations aimed at further reductions in aircraft weight and drag.

The cost and the future questionable availability of fuel are driving forces that require new techniques, new materials and new concepts. Our foreign competitors, all of whom are heavily subsidized by their governments, are moving ahead of us in some of these technical areas. We cannot afford to go the way of the American automobile industry.

Assets and Liabilities in Research and World Trade

Any evaluation of our assets and liabilities with regard to basic aeronautical research and development capabilities, and international trade policy, is beleaguered by perceptions. It is a multifaceted question. For example, one of aeronautics' greatest assets is the intellectual and creative engineering capacity embodied in NASA. Given adequate financial resources by Congress, and the support and encouragement of the President to get back into aeronautical research that does not duplicate private sec-

tor efforts, NASA could lead the way for aviation technology's next quantum jump.

But R&D has become so politicized that what could be and should be a national asset has become somewhat of a liability. It is a liability because funding is minimal, and encouragement for actions meek. The result is that NASA is being damned by faint praise. And we manufacturers, with high hopes for the vigorous application of NASA's unique abilities in basic research, have become frustrated and impatient.

NASA can and should expand its aeronautical R&D, particularly in the areas of basic research. Congress should see to it by appropriate funding and validation. Moreover, the President should support accelerated research and development as a national policy. Then and only then can NASA's aeronautical endeavors be called an asset, which Webster defines as "anything owned that has exchange value; a valuable or desirable thing to have."

The recently concluded Multilateral Trade Negotiations (MTN) brought forth an unprecedented agreement for the international trade of civil aircraft. It held a promise for free fair trade, without tariffs and non-tariff barriers, or at least minimal restriction without discriminatory application.

The U.S. aircraft industry strongly supported the development and finalization of the MTN agreement. But time has shown that we may have given away far too much and in return got very little. It has been suggested that we got the sleeves from the vest but gave away the coat and trousers.

Brazil and Israel, for example, are not signatories; they can sell here, but we can't sell there. Japan restricts aircraft imports but has unrestricted access to U.S. markets. That kind of policy, which lacks quid pro quo, cannot be called an asset. Also, the Export-Import Bank faces significant reductions in funding for essential loan guarantees, which our foreign competitors enjoy from their governments.

The major asset of our international trade policy, as it was recently pronounced by Ambassador Bill Brock is the promise of an aggressive government policy with accompanying programs to promote U.S. exports. The promise of support and the willingness to listen to complaints gives us hope that perhaps we will not lose our worldwide dominance after all.

We are very concerned that a large faction of the Congress still believes the Domestic International Sales Corporation (DISC) should be abolished. DISC was authorized in 1971 to increase American exports, thus improving the U.S. balance of trade. It enables corporations to form DISC subsidiaries, consolidate all their income from exports and defer a portion of taxes levied on that income.

Over the past 10 years over 8,000 DISC subsidiaries have been established, many of them in general aviation. Since it's inception in 1973, our company's DISC has handled nearly one-half billion dollars in export sales. Not only have DISC organizations helped increase shipments abroad, they have created more jobs at home. But if DISC is discontinued, the net result could mean higher export prices which, in turn, might reduce general aviation's total sales volume.

Enhancing Competition in World Markets

The threat of foreign competition may not emanate solely from abroad. Granted, American business jet companies have successfully led in sales in the world marketplace. But official neglect, such as government policies of monetary "benign neglect," could be consequential. For example, the abandonment of free trade principles in the name of human rights, a Carter Administration policy still on the books, has handicapped the industry by severely limiting potential sales.

Over-zealous bureaucratic intervention manifested by export license control policies, as part of COCOM—an international agreement to control high technology exports to the Eastern bloc nations—is yet another marketing impediment. There have been several instances where applications to export have been delayed to a point where the sale was lost. There have been incidents where foreign manufacturers of a COCOM nation stepped in and sold their aircraft—approved quickly by their respective governments—while the U.S. company application languished in our Department of Commerce.

Foreign governments as a matter of official policy promote the sale of their nation's aircraft. The level of direct foreign government subsidy to a particular country's aircraft manufacturing industry varies, but its existence is a serious threat to the U.S. plane builders, not only in our own domestic market, but in "third world" nations as well. These are the influencing government actions —or lack of action—that could increase the relative competitiveness of foreign manufacturers.

There are a number of actions that the government might take to enhance the American industry's ability to compete effectively worldwide:

The provisions of the MTN Agreement on International Trade of Civil Aircraft should be enforced, particularly with regard to sales in third world countries.

The Department of Commerce commodity list for controlling export licenses should be minimized.

Government programs within our embassies overseas should be expanded to promote the sales of U.S.-built aircraft.

The Export-Import Bank should be funded and urged to permit broader use of its guaranteed loan programs supporting the sale of all civil aircraft.

Adequate funding should be provided, and a higher level of activity mandated, for NASA basic aeronautical research.

Finally, even better tax incentives for private industry research and development should be provided.

CERTIFICATED CIVIL BUSINESS JETS MANUFACTURED WORLDWIDE
(As of July 1, 1981)

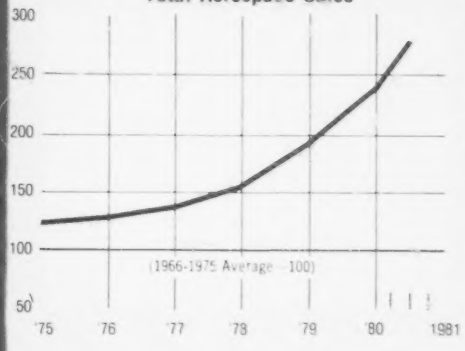
	Number of Units	Percent of Market Share
Gates Learjet*	1,141	25.8
Cessna Citation*	896	20.3
Dassault (Falcon)	610	13.8
Hawker Siddeley 125	479	10.8
Rockwell Sabre liner*	428	9.7
Israeli A/I (Westwind)	316	7.1
Gulfstream II/III*	266	6.0
Lockheed JetStar*	200	4.5
Corvett	40	0.9
Hansa Jet	35	0.8
Canadair Challenger	11	0.3

*U.S. companies. Total U.S. market share is 66.3 percent.

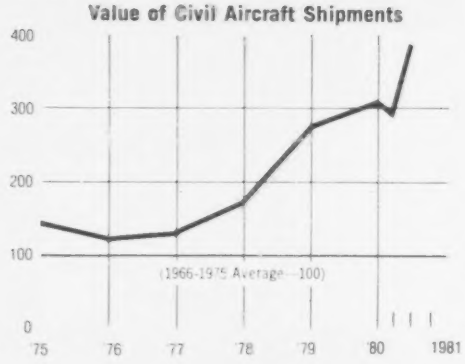
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales



Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average

ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 2nd QTR. 1981
AEROSPACE SALES: TOTAL	**Billion $**	**Annually**	**24.2**	**50.6**	**61.7**	**66.4**
	Billion $	**Quarterly**	**6.1**	**14.8**	**16.1**	**19.5**
AEROSPACE SALES: TOTAL	***Billion $***	***Annually***	***25.6***	***29.9***	***33.9***	***35.7***
(In Constant Dollars, 1972=100)	***Billion $***	***Quarterly***	***6.4***	***8.4***	***8.6***	***10.2***
AEROSPACE PRIME CONTRACT						
AWARDS: TOTAL	**Billion $**	**Quarterly**	**5.8**	**18.6**	**19.2**	**19.8**
U.S. Government	**Billion $**	**Quarterly**	**4.1**	**7.5**	**9.8**	**9.8**
Other Customers	**Billion $**	**Quarterly**	**1.7**	**11.1**	**9.4**	**10.0**
BACKLOG (Major Aerospace Mfgrs): TOTAL	**Billion $**	**Quarterly**	**28.6**	**89.3**	**94.7**	**95.5**
U.S. Government	**Billion $**	**Quarterly**	**15.9**	**36.9**	**39.5**	**41.4**
Other Customers	**Billion $**	**Quarterly**	**12.7**	**52.4**	**55.2**	**54.1**
DEPARTMENT OF DEFENSE						
Aerospace Obligations: TOTAL	**Million $**	**Quarterly**	**2,712**	**5,144**	**5,384**	**5,819**
Aircraft Procurement	**Million $**	**Quarterly**	**1,986**	**4,050**	**4,241**	**4,797**
Missiles Procurement	**Million $**	**Quarterly**	**726**	**1,094**	**1,143**	**1,022**
Aerospace Outlays: TOTAL	**Million $**	**Quarterly**	**2,405**	**3,444**	**3,886**	**4,551**
Aircraft Procurement	**Million $**	**Quarterly**	**1,741**	**2,849**	**3,055**	**3,563**
Missiles Procurement	**Million $**	**Quarterly**	**664**	**595**	**831**	**988**
NASA RESEARCH AND DEVELOPMENT						
Obligations	**Million $**	**Quarterly**	**780**	**955**	**1,522**	**1,138**
Expenditures	**Million $**	**Quarterly**	**789**	**958**	**1,077**	**1,166**
EXPORTS						
Civil and Military: TOTAL	**Million $**	**Quarterly**	**1,038**	**3,860**	**4,253**	**4,987**
New Commercial Transports	**Million $**	**Quarterly**	**345**	**1,546**	**1,699**	**2,282**
EMPLOYMENT: TOTAL	**Thousands**	**End of Quarter**	**1,166**	**1,187**	**1,215**	**1,210**
Aircraft	**Thousands**	**End of Quarter**	**650**	**654**	**665**	**660**
Missiles & Space	**Thousands**	**End of Quarter**	**114**	**112**	**119**	**118**
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	**Dollars**	**End of Quarter**	**4.38**	**9.16**	**9.97**	**10.18**
PROFITS (AFTER TAX)						
Aerospace — Based on Sales	**Percent**	**Quarterly**	**2.7**	**4.3**	**5.7**	**4.5**
All Manufacturing — Based on Sales	**Percent**	**Quarterly**	**4.8**	**4.8**	**4.7**	**5.5**

* Quarterly average computed as one-fourth of annual average.
† Preceding period refers to quarter preceding latest period shown.

Source: Aerospace Industries Association

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The Boeing Company
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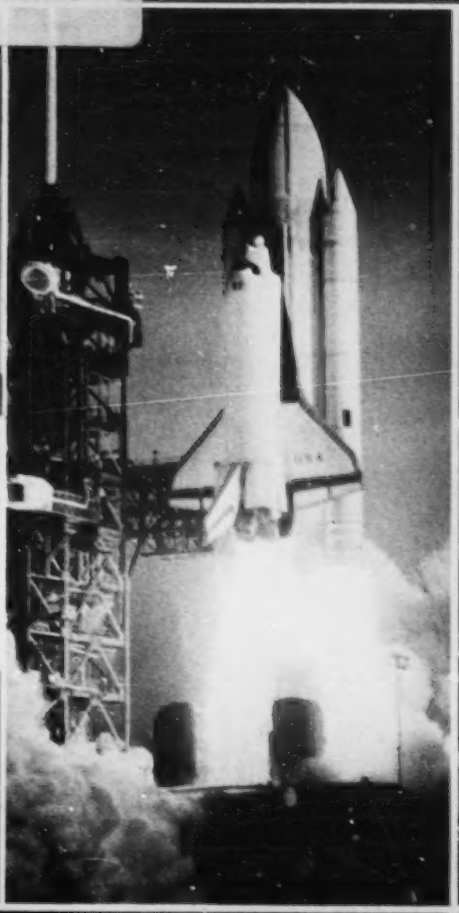

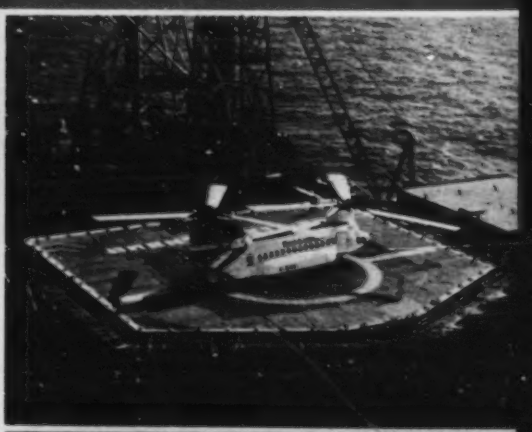

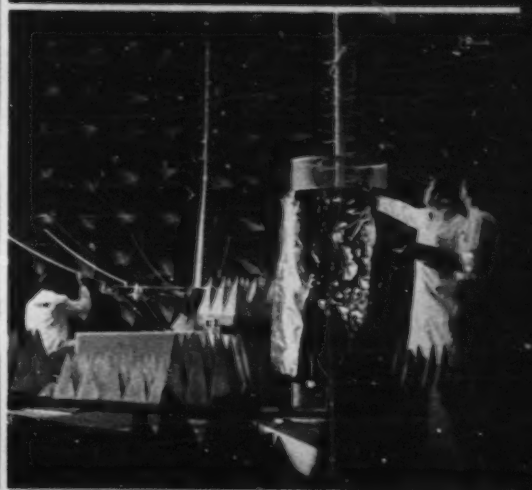

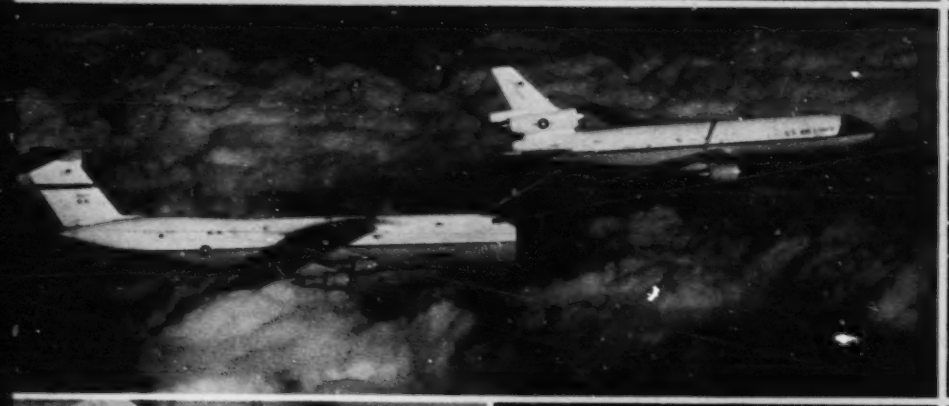

AEROSPACE REVIEW AND FORECAST 1981/1982

THE AEROSPACE OUTLOOK: 1982

BY KARL G. HARR, JR.
President, Aerospace Industries Association

It is difficult at any time to project aerospace activity for a decade or so, but it is especially difficult today because of the uncertain direction of our national economy. While the state of the economy obviously affects all industries, aerospace is particularly sensitive to economic fluctuations and the impact of international events. One reason is that our principal customers are government agencies whose funding levels are economy-dependent. Another is that our major non-government customers are the airlines, whose traffic volume—including the hard-core business travel—swings up and down with changing economic conditions. So, in the absence of a clear picture of where our economy is going, the view of the aerospace industry's prospects for the 1980s is somewhat hazy.

The commercial aviation outlook, so bright only a couple years ago, has taken a turn for the worse. The economic slowdown affecting much of the free world has caused airlines to defer commitments for new equipment. We still feel that the airlines will purchase large numbers of new and replacement aircraft when world economic conditions improve and traffic volume trends upward. But we can't say when that will happen.

The world transport market is now estimated at about $125 billion. That's in 1982 dollars, whereas other projections were in 1980 or 1981 dollars, so the figure is well below earlier estimates. Of course, that still represents a very large market. The big question is how much of that market U.S. industry will retain in the face of stiff and growing foreign competition. The competition is real, it is perhaps stronger than expected, and its biggest impact is in sales to foreign airlines which traditionally constitute about 60 percent of the market. Our major competitive problem is the fact that government-supported foreign manufacturers can offer low financing rates which our companies are unable to match.

There is another consideration: the possibility that the market itself may decline below current projections, due to the airlines' inability to earn enough money to carry through their reequipment plans. The U.S. airlines represent our primary sales base. For the year just ended, they recorded another operating loss, their second straight. It is impossible to predict when their financial health will recover sufficiently to permit the large capital investment necessary for their contemplated aircraft purchases.

So, looking at the overall commercial aircraft picture, we must face the fact that the U.S. share of the world market will decline to some degree as the result of competition from abroad, and that our vital domestic market could erode if U.S. airline profitability does not improve significantly.

In other segments of its civil aviation business, the industry is also experiencing problems. Helicopter sales dropped sharply in 1981 after three years of dramatic growth. General aviation deliveries have declined in each of the past two years. Sales of business jets continue at a high level, but 1981 orders were below earlier projections. There are a number of contributing factors affecting sales in these areas, but the principal difficulty is the same as that facing manufacturers of large transports—the more attractive financing terms offered by foreign competitors. With the help of the U.S. government, the industry is trying to negotiate an international accord under which U.S. manufacturers will have equal opportunity to compete in the international market. There has been some progress, but we cannot predict an early solution.

In commercial activity, space or defense, all projections about the future turn on the crucial question of whether we, as a nation, can get inflation, under control. If we lose the battle against inflation, we might as well forget, for example, the meaningful defense build-up that is projected. Defense programs rarely if ever take fewer than three years to complete, and if high inflation rates persist we'll be back in the same old swamp that has plagued us during recent high inflation years. We will continue to see a program for a set quantity of production units running into the fact that—after one, two, three or four years—there isn't enough money to produce that quantity because of inflation. This invariably produces cancellations, cutbacks, and deferrals. The best result of this syndrome is that the nation's defense system gets substantially fewer weapon systems for substantially higher outlays; the worst is that substantial outlays occur for which *no* production models are placed in inventory.

The trend in NASA funding, in both aeronautics and astronautics, is a matter of deep concern. And we feel it is our duty to point out that such a trend can well be penny-wise and pound foolish. NASA's aeronautical research is vital to the commercial aircraft industry's competitiveness in the international area. Industry, of course, conducts its own extensive aeronautical R&D. But for many years the nation has enjoyed a government-industry relationship wherein the government, in the national interest, conducts supportive long-range research in areas where the risk is too great and the payoff too distant to justify industry outlays. The relationship has contributed in considerable degree to our preeminence in transport aircraft development and production. Our competitors are getting that kind of help from their governments. But reductions in NASA funding for aeronautical research and technology over a period of years have sharply diminished NASA's ability to fill its important complementary role. This means that a lot of research important to our competitive posture may never be accomplished—and in future years that could have disastrous consequences in one of the very few areas where the United States still enjoys a large trade surplus.

In the space effort, we have spent a decade and a lot of money developing the advanced capability that the Shuttle represents, and having done so we are surrendering our chance to exploit that capability, to pursue the direct bene-

fits that space affords. Perhaps even more important are the indirect benefits—the scientific and technological knowledge we would acquire in a comprehensive space program. Science is the foundation of future technology and its application is not limited to aerospace, but stretches across the board of American technological enterprise. By its challenging nature, by the fact that it delves into research frontiers not otherwise explored, space is a prime contributor to the national technology base. But at the rate of space exploration projected, we are going to lose a lot of that scientific and technological input and it will impact our industry and many other industries some years down the road. Even if there is renewed support at some later date, no belated infusion of new money can undo the damage that is now being done.

It would seem logical that any economic recovery plan would consider the importance of expanding our national technology base to revivify our industrial competitiveness. I feel that the matter of NASA funding is a case where, in the hectic quest for budget reductions, the future impact on our economy was inadequately considered. It merits reconsideration.

Never before in our nation's history has any Administration been confronted, to the degree that this Administration is, with its two big problems. We have never before had anything like the sustained high inflation of the past several years. And we have never before faced in peacetime anything like the military threat that has now been thrown at us. The unprecedented nature of this challenge and the respone it requires go a long way, it seems to me, to answer those who consider the Administration's program draconian.

Several facts shine through the haze:

First, unless we solve the problem of inflation, we can forget all the rest.

Second, whereas no one can yet irrefutably prove whether the President's economic program will or will not work, it is the program we elected him to carry out and he has pursued it with the utmost vigor and determination.

Third, this is the first comprehensive and concentrated attack on inflation any recent Administration has undertaken and none of its opponents has come up with a viable alternative.

Fourth and last, if we do not let the Administration see the program through, not only will we never know whether it would have worked, but it will be a cold day in hell before any national leader ever tries it again.

There are some hopeful signs—reduced inflation rates, greatly expanded personal savings, at least temporarily reduced interest rates, and at least respectable disagreement among the economists as to how the Administration's effort is going. In any case, it would be a sad day for this country if, through lack of resolve, flabbiness of character, or simple special interest greed, we failed to give the President's program a fair chance.

Candor requires me to state that, as an interest group, we of the aerospace industry have spoken out and will continue to speak with vigor where we see, or believe we see, actions based on misinformation or misperceptions of their effects; actions taken for short-term objectives which will have unintended and unsalvageable long term impact; and actions which we preceive will have a totally different effect than that intended. I see nothing wrong with this. In fact, we should do it and we must do it as must other interest groups, for that is how the system works.

But we will do this, as we hope others will, within the context of full support for the Administration's economic recovery program, in the belief that the success or failure of that program will determine the fate of all of us. So let's at least give it a fair shot.

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EDITOR • Gerald J. McAllister

ASSOCIATE EDITORS • James J. Haggerty

Jean Ross Howard

ART DIRECTOR • James J. Fisher

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By James J. Haggerty

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The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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AEROSPACE HIGHL

BY JAMES J. HAGGERTY

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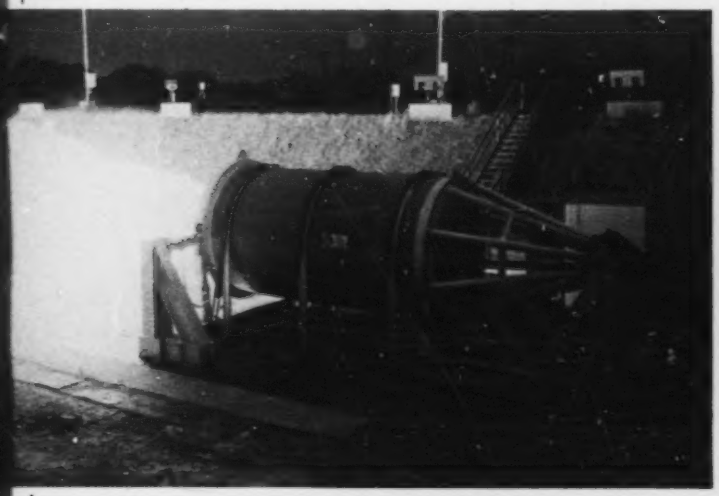

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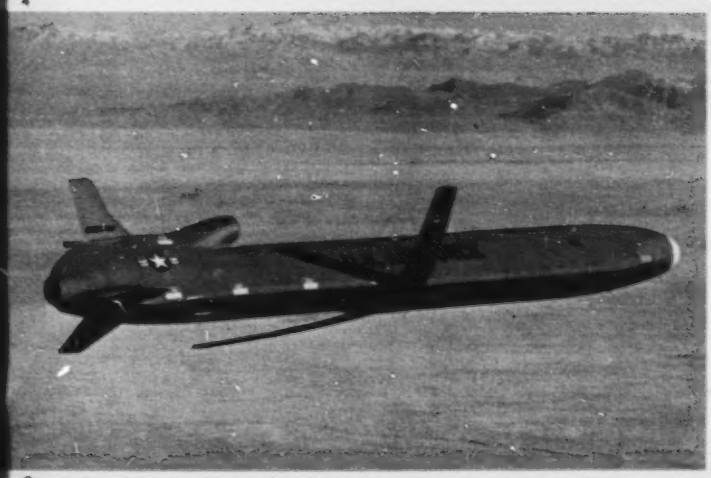

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GHTS 1981

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1. Development of the MX missile progressed toward first flight early in 1983. In photo, the initial firing test of the MX's second stage in April.
2. In October, President Reagan proposed production of 100 modified and updated B-1 bombers.
3. The USS *Ohio*, first of the nuclear-powered Trident ballistic missile submarines, completed sea trials during the year.
4. First production models of the AGM-86B Air Launched Cruise Missile were delivered to the Air Force in November.
5. In April, the Army began firing tests of the new Multiple Launch Rocket System from a self-propelled launcher/loader.
6. The first KC-10 advanced cargo/tanker aircraft was delivered to the Air Force in March.

The major 1981 defense development was President Reagan's October announcement of the Administration's strategic weapons program, including plans to produce both the MX intercontinental missile and an advanced variant of the B-1 bomber. The plan also includes development of the Advanced Technology Bomber, featuring reduced radar signature ("stealth") technology, for operational use in the 1990s.

The Administration's proposal called for "at least" 100 operational MXs, some of which would be deployed initially in converted Minuteman silos "superhardened" for greater survivability. Decision as to the long-term basing mode for the rest of the missiles would be deferred until 1984, but the former multiple protective shelter, or "shell game" concept, would be scrapped.

The President proposed production of 100 modified and updated B-1s known as B-1Bs. To be built by Rockwell International, with Boeing Military Airplane Company as associate contractor, they would be equipped to carry cruise missiles. Initial operational service was targeted for 1986.

Immediately after the President's announcement, the Department of Defense launched the Advanced Technology Bomber program with a contract award to Northrop Corporation to begin development of the "stealth" aircraft. Boeing was named principal subcontractor and Vought Corporation was assigned responsibility for guidance and control systems.

Among other elements of the Administration's multi-point strategic weapons plan were development of the Navy/Lockheed Trident 2 submarine-launched ballistic missile for 1989 deployment; fitting attack submarines with the General Dynamics Tomahawk cruise missile; accelerated research on deep underground basing and on aerial launch as future MX options; and a large-scale program of command, control and communications improvements.

While the Administration was formulating the strategic weapons plan, development work progressed on the MX missile with wind tunnel model tests of the final configuration and ground tests of the various stages. First flight of the complete four-stage missile was scheduled for early 1983. Associate contractors for the stages are Thiokol Corporation's Wasatch Division (Stage I); Aerojet Strategic Propulsion Company (Stage II); Hercules Aerospace Division (Stage III); and Rockwell's Rocketdyne Division (Stage IV). In addition to stage tests, Northrop Corporation's MX inertial guidance platform was successfully tested on rocket-powered sled runs during the year.

In other 1981 missile developments,

• The Department of Defense accelerated development of the Army's Pershing II ballistic missile. First flight is scheduled for early 1982.

• The USS *Ohio*, first of the nuclear-powered Trident ballistic missile submarines, completed sea trials and was formally commissioned on November 11. General Dynamics' Electric Boat Division built the *Ohio;* its Trident 1 missiles are manufactured by Lockheed Missiles & Space Company.

• The terrain contour matching guidance system used in both land and sea-launched versions of the General Dynamics' Tomahawk cruise missile was successfully tested during the year, including night tests in September.

• First production models of the Boeing-built AGM-86B Air Launched Cruise Missile were delivered to the Air Force in November.

• Boeing Aerospace Company and Vought Corporation were awarded contracts for advanced development of the ASAT (anti-satellite) space defense system, a two-stage rocket with a miniature homing vehicle that would be fighter-launched to intercept hostile satellites.

• Raytheon Company and Hughes Aircraft Company conducted successful target firings (from fighter aircraft) of two competing versions of the Air Force/Navy AMRAAM (Advanced Medium Range Air-to-Air Missile).

• In April, the Army began firing tests of the Vought Multiple Launch Rocket System from a self-propelled launcher/loader. Initial tests involved single and multiple-round firings of about 100 rockets, to be followed by production qualification and operational test launches in 1982.

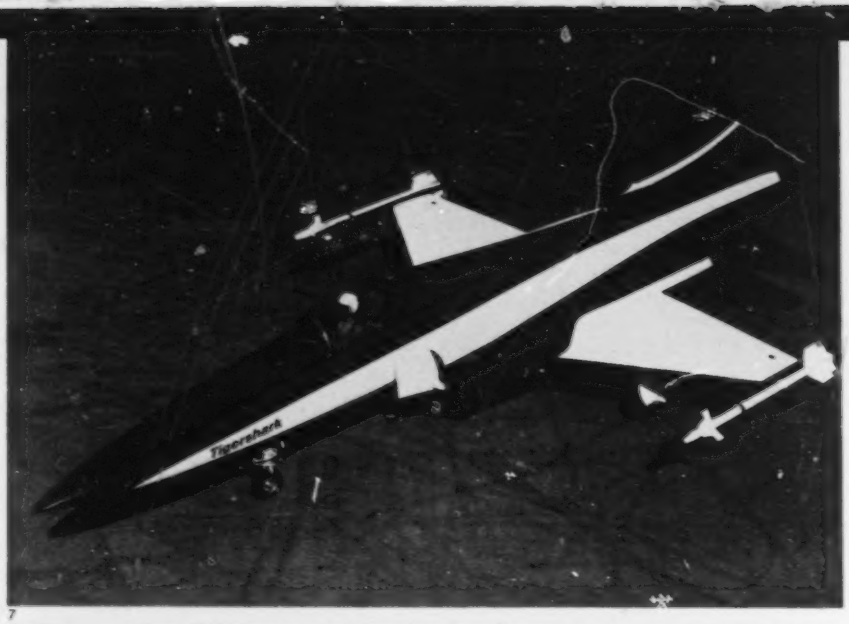
• Following long-range tests conducted earlier in the year, Hughes Aircraft delivered the first production models of the AIM-54C Improved Phoenix to the Navy in November. The AIM-54C is an air-to-air weapon designed for use aboard the F-14 fighter.

• Boeing Aerospace and its associate contractor Hughes Aircraft completed flight testing of the Army's Roland anti-aircraft missile system in mid-year and began production deliveries. The French/German-designed missile is being built in the U.S. under license.

• In August, the Navy started guided flight tests of the RAM (Rolling Airframe Missile) shipboard defense system. General Dynamics' Pomona Division is prime contractor for the project, jointly sponsored by the U.S., West Germany and Denmark.

• The USAF/Hughes Imaging Infrared Maverick air-to-surface missile completed the first phase of its development testing in August, demonstrating high accuracy in hits on tanks and other surface vehicles. Testing under combat-like conditions was under way at year-end and production was expected to begin in 1982.

• Major military aircraft in production



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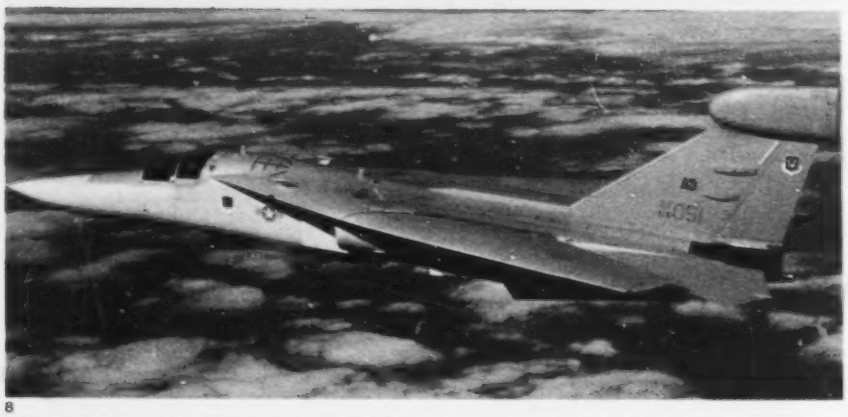

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7. In development was the F-5G Tigershark, whose first flight was targeted for September 1982.
8. The first production model of the USAF EF-111A tactical jamming aircraft made its initial flight in June.
9. The Army's YAH-64 advanced attack helicopter passed 3,000 flight test hours in August.
10. The YEH-60A, an Army electronic warfare helicopter, made its first flight in October.

10

during 1981 included the USAF's F-15 fighter (McDonnell Douglas), F-16 fighter (General Dynamics) and the A-10 attack plane (Fairchild Republic); the USAF/Navy A-7 attack bomber (Vought); and the Navy's F/A-18 fighter/attack plane (McDonnell Douglas). In limited production was the Boeing E-3A Airborne Warning and Control System (AWACS).

In other military aircraft developments during the year,

- The first McDonnell Douglas KC-10A advanced cargo/tanker aircraft was delivered to the Air Force on March 17. Four additional KC-10As were delivered later in the year and the aircraft was put through initial aerial refueling tests.
- Northrop continued development of its F-5G fighter intended for the international market. First flight was planned for September 1982 and initial deliveries were targeted for mid-year 1983.
- The first production model of the USAF/General Dynamics/Grumman EF-111A tactical jamming aircraft made its first flight on June 26. First deliveries were made in the fall.
- The first of 35 USAF/Lockheed TR-1 tactical reconnaissance aircraft, enlarged versions of the U-2, was rolled out July 15.
- At year-end, the Navy/McDonnell Douglas F-18 Hornet was in the final stages of developmental testing and also undergoing operational testing with two Navy/Marine Corps squadrons.
- A new version of the Navy/Grumman F-14 fighter, equipped with General Electric F101 engines, started an extensive flight test program on July 14.
- The Marine Corps/McDonnell Douglas AV-8B Harrier II V/STOL combat aircraft made its initial flight on November 5.

Among military helicopter events:

- The Army's YAH-64 Apache advanced attack helicopter continued its operational test program and passed the 3,000 flight hour mark in August.
- In March and April, the Navy/Sikorsky SH-60B Seahawk was put through sea trials aboard a frigate to test its operation from the ship's deck.
- The Army/Sikorsky YEH-60A Quick Fix electronic warfare helicopter made its first flight in October.
- Bell Helicopter Textron won an Army competition for the Near Term Scout Helicopter and received a engineering development contract. The first helicopter is scheduled for 1984 delivery.
- The first of 10 Navy/Kaman SH-2F Light Airborne Multi-Purpose System helicopters was rolled out on September 23 and was delivered to the Navy on November 5.
- The Marine Corps took its first delivery of a Sikorsky CH-53E Super Stallion in June. The helicopters are scheduled for operational service in 1983.

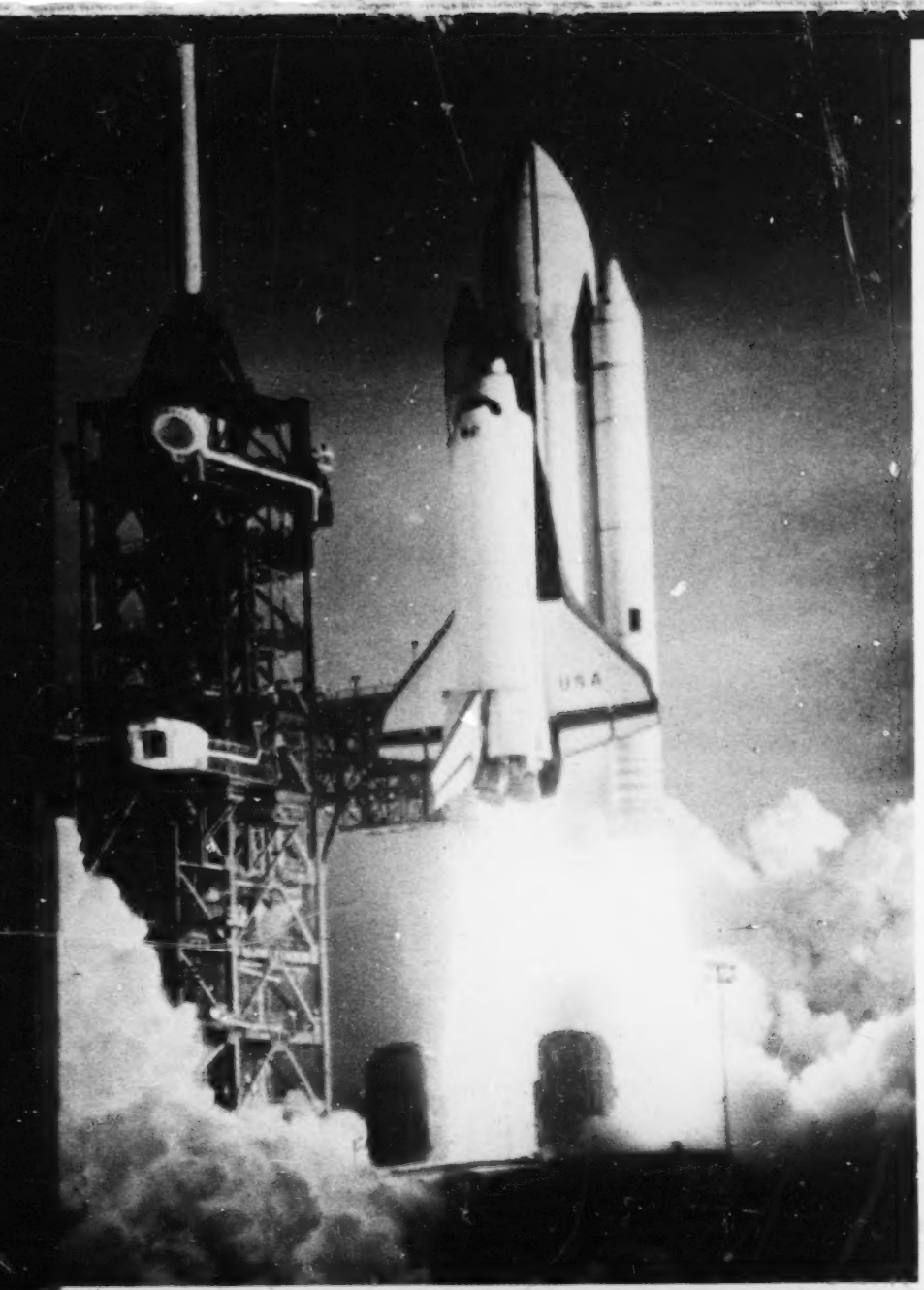
Space

For the National Aeronautics Space Administration, the highlights of 1981 were the debut of the Space Shuttle and another Voyager encounter with the ringed planet Saturn.

On April 14, the Shuttle Orbiter *Columbia* made history by becoming the first spacecraft to end an orbital mission by making a conventional airplane-like landing at an Earth base. The near flawless first trip to space took slightly more than 54 hours. The Orbiter scored another historical "first" on November 12-14 when it became the first spacecraft to complete a second flight, demonstrating the Shuttle's reusability. Planned for five days, the STS-2 mission was shortened to 54 hours due to malfunction of one of the Orbiter's three electricity-generating fuel cell powerplants. Nonetheless, crewmen Joe Engle and Dick Truly were able to accelerate the schedule of checkouts and experiments to accomplish most objectives.

Following up the November 1980 visit of Voyager 1, the companion Voyager 2 spacecraft encountered Saturn in August 1981. On August 20, the spacecraft passed within 63,000 miles of the planet, closer by more than 14,000 miles than its predecessor. Approaching on a different flight path, Voyager 2 provided some 18,000 new images and volumes of information complementary to the findings of Voyager 1, including the most comprehensive examination to date of Saturn's rings and a detailed look at several of the planet's moons. The planetary encounter concluded on September 28 and Voyager 2 swept into a trajectory that will take it to encounters with Uranus in 1986 and Neptune in 1989. Jet Propulsion Laboratory built the Voyager spacecraft and managed the program for NASA.

In other planetary exploration, the Pioneer Venus Orbiter—built by Hughes Aircraft Company—continued to orbit Venus and relay radar data for mapping the cloud-shrouded planet's never-seen surface; it completed the mapping task in mid-year but continued to report atmospheric data. On Mars, Viking Lander 1—sole survivor of four Martin-Marietta-built Viking Landers and Orbiters—marked the fifth anniversary (in July) of



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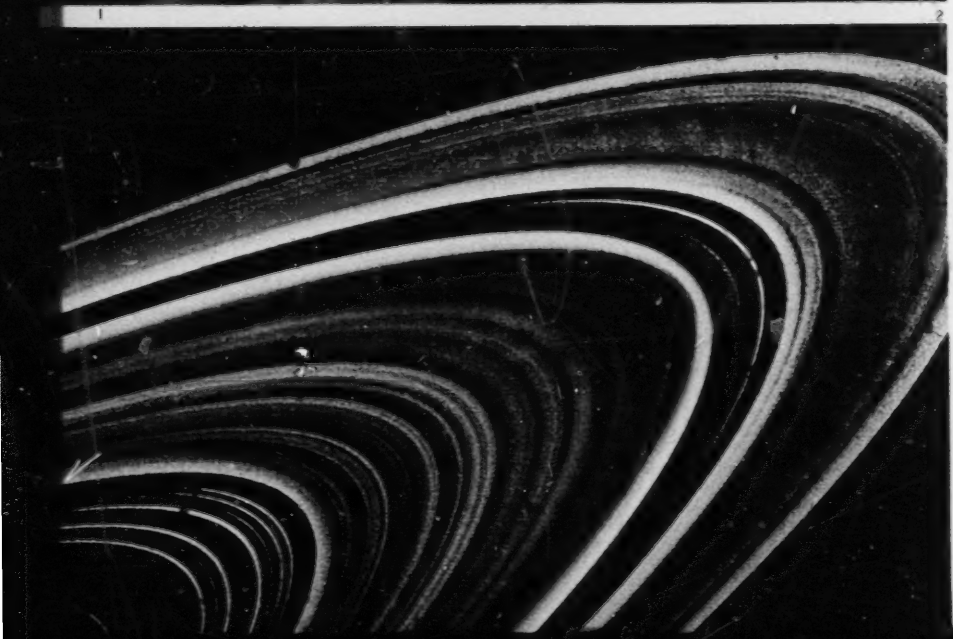

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1. The Space Shuttle successfully completed its initial orbital flight in April and a second in November.
2. The Voyager 2 spacecraft encountered Saturn in August and provided this dramatic computer-processed view of Saturn's rings in which the different colors represent variations in the chemical composition of the ring system.

its data reporting service, originally planned for only four months. At year-end, Lander 1 was still sending weekly weather and photographic reports.

Among 1980 civil spacecraft operations,

• The second of 12 planned Intelsat V communications satellites was sent into orbit May 25 and it started operations in mid-July. Developed by Ford Aerospace & Communications Corporation for the International Telecommunications Satellite Organization, Intelsat V has double the capacity of its predecessor—Intelsat IV-A—with two TV channels and some 12,000 simultaneous telephone conversations.

• On August 3, NASA orbited the Dynamic Explorers 1 and 2 on a single launch. Built by RCA Astro Electronics Division, the satellites are designed to study complex interactions of solar energy and magnetic forces in the ionosphere and upper atmosphere.

• Percheron, the first non-government space booster developed in the U.S., exploded on its pad during an initial launch attempt on August 5. Space Services, Inc. is developing the 55-foot rocket.

• On September 24, NASA launched for Satellite Business Systems the Hughes-built SBS-2, second of three geosynchronous satellites for business communications. Satellite Business Systems is a partnership of IBM Corporation, Comsat General Corporation and Aetna Life and Casualty.

• NASA's Solar Mesosphere Explorer (SME) was launched October 6. Built by Ball Aerospace Systems Division, SME is an atmospheric research satellite designed to study reactions between sunlight, ozone and other chemicals in the atmosphere.

• RCA Satcom III-R, designed for distribution of video programming to cable TV systems, was launched by NASA on November 19, joining two earlier satellites of the RCA network. RCA Americom manages the Satcom program and RCA Astro Electronics built the spacecraft.

• Military launches, other than classified programs, included:

• The first of three Nova navigation satellites, improved versions of the Navy's Transit, was orbited on May 14. Nova is built by RCA Astro Electronics.

• The fifth of the FLTSATCOM series of communications satellites was launched August 6. A joint USAF/Navy development, the FLTSATCOM satellites are built by TRW Inc.'s Defense and Space Systems Group. The satellites are the spaceborne portion of a worldwide Department of Defense system for communications among aircraft, ships, submarines and ground stations.

Chief among NASA/DoD space programs in development status during 1981 was the Space Shuttle, which was scheduled for two more test flights—probably in March and July 1982—prior to the start of operational service in the fourth quarter of 1982. The second of four planned Orbiters—*Challenger*—was to be delivered in June 1982. Rockwell International is Shuttle prime contractor; Thiokol Corporation builds the two solid rocket boosters and Martin Marietta the large fuel tank.

Other NASA programs in development included:

• Landsat D, the fourth and most advanced member of the Earth resources monitoring satellite series, to be launched on one of the earliest operational Shuttle missions. General Electric Company's Space Division is contractor.

• TRW-built Tracking and Data Relay Satellites (TDRS), two of which, plus a backup in orbit, will relay communications among Earth bases, the Shuttle Orbiter and unmanned payloads in space. First launch is planned for the first operational Shuttle flight.

• The Infrared Astronomical Satellite (IRAS), scheduled for 1982 launch, which will conduct a systematic survey of a million infrared sources in the universe, investigating one of the least explored areas of the spectrum. IRAS is built and managed by Jet Propulsion Laboratory.

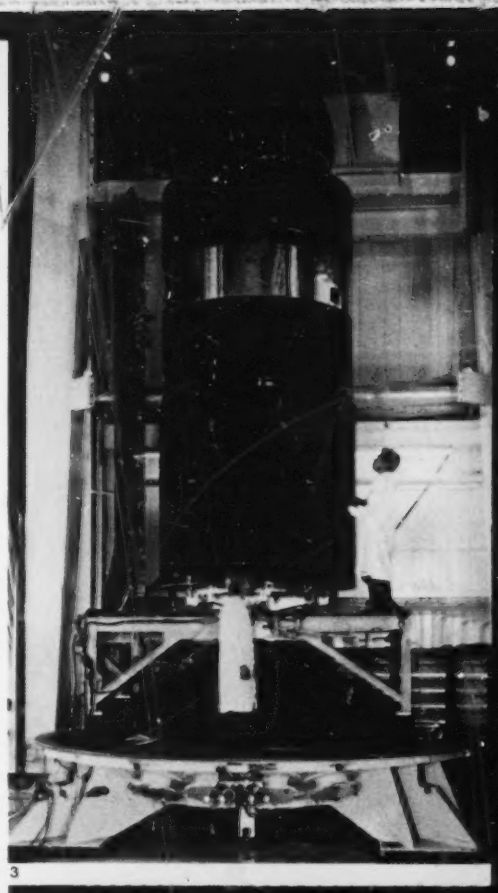
• The Long Duration Exposure Facility (LDEF), designed to provide new information on how space radiations affect humans and spacecraft materials, structures and on-board equipment over long periods. To be launched in 1984, the LDEF's 47 experiments will be exposed to the space environment for a year, then the Shuttle Orbiter will retrieve the LDEF for detailed examination of its specimens in Earth laboratories. The program is managed by Langley Research Center.

• Galileo, a project involving two spacecraft, one to orbit the planet Jupiter, the other a probe designed to descend through the planet's atmosphere. Galileo is to be Shuttle-launched in 1985. Hughes Aircraft is prime contractor for the atmospheric probe.

• The Space Telescope, NASA's premier space science project, an orbiting observatory capable of looking seven times further into space than the largest Earth-based telescopes. The telescope will be introduced to service in 1985. Lockheed Missile & Space Company is prime contractor and Perkin-Elmer Corporation is producing the optical assembly.

• The Solar Optical Telescope, designed to operate within the Shuttle Orbiter's payload bay, thus allowing reusability. The four-foot-diameter telescope will make a series of one-week missions, beginning in 1987, observing the Sun through various filters in the visible, infrared and ultraviolet regions of the spectrum. NASA's Office of Space Science is managing the program.

• Planned for 1988 launch, the Gamma



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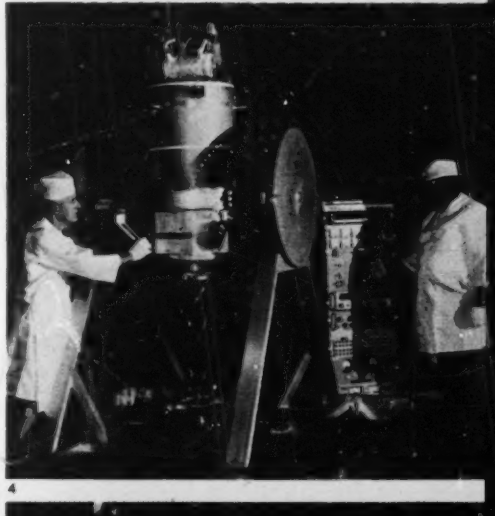

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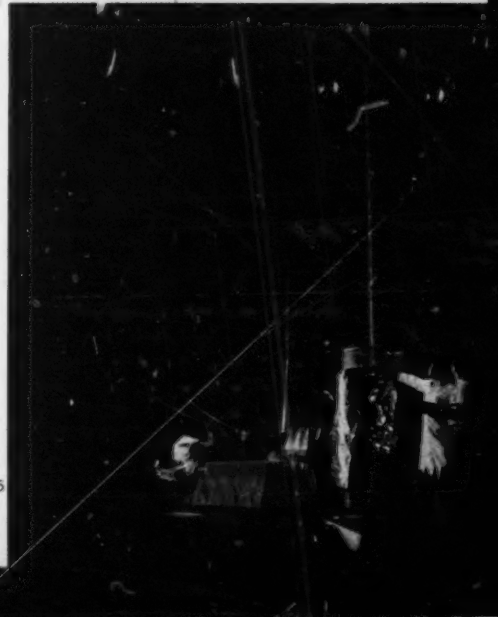

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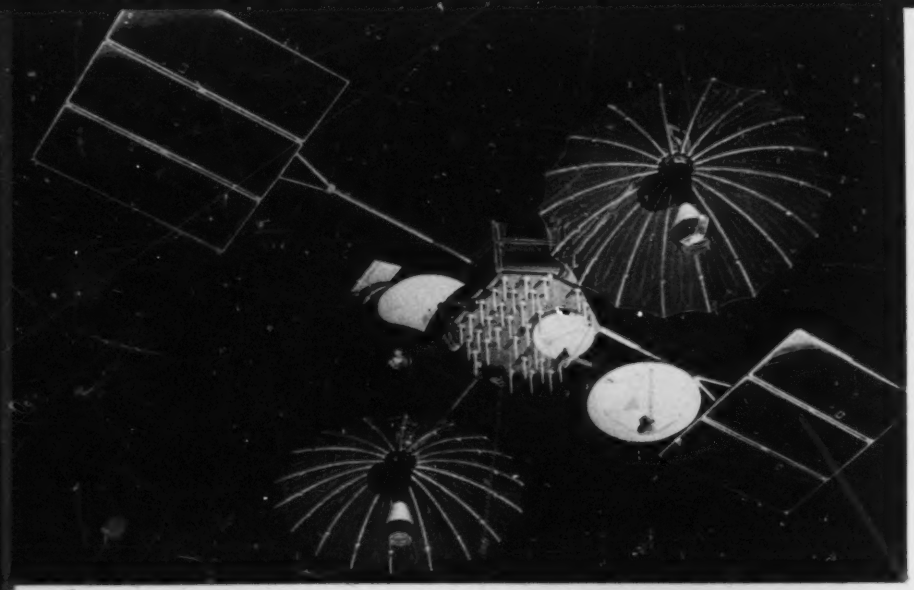

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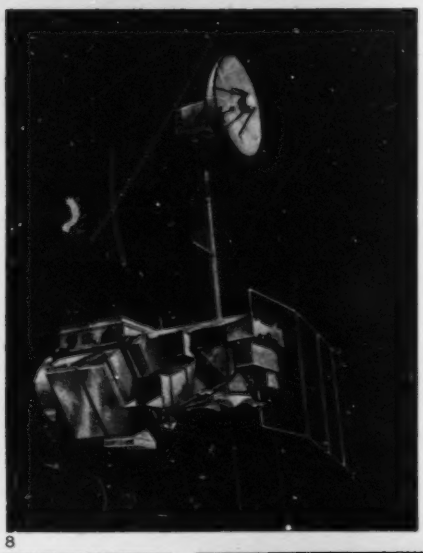

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Ray Observatory will study how gamma rays are produced and where they come from. TRW Inc. is working on a design under contract with Goddard Space Flight Center, project manager.

• The Venus Orbiting Imaging Radar (VOIR) will follow up the radar mapping of Venus initiated by the Pioneer Venus spacecraft, but will employ an advanced radar of far greater resolution. Hughes Aircraft is developing the radar. VOIR launch is planned for 1988.

• The Advanced X-ray Observatory, targeted for service in 1989, will be capable of detecting celestial X-ray sources 50 to 100 times weaker than predecessor spacecraft have detected. Marshall Space Flight Center, which manages the project, is studying contractor proposals.

Among unclassified military space developments, a major program is the Navstar Global Positioning System, designed to provide more precise navigation information for ships, aircraft, missiles and ground vehicles. During 1981, the USAF continued to operate an interim system of six satellites, which will be replaced by an operational network of 18 more advanced spacecraft by 1985. Rockwell International manufactures the satellites.

Other military spacecraft in development include the third generation Defense Satellite Communications System (DSCS-III), built by General Electric's Space Division, and Hughes Aircraft's Leasat, a DoD-leased satellite which will relay signals to mobile and fixed air, surface and subsurface stations. DoD is also planning development, beginning in 1983, of an advanced EHF (extremely high frequency) communications satellite system called Milstar.

3. Sent into orbit in September was the SBS-2, second of three spacecraft of the Satellite Business Systems network.

4. The first of three Nova navigation satellites for the Navy, shown in pre-launch checkout, was orbited in May.

5. Shown undergoing antenna testing is the USAF/Navy FLTSATCOM-E, fifth in a DoD communications satellite series, launched in August.

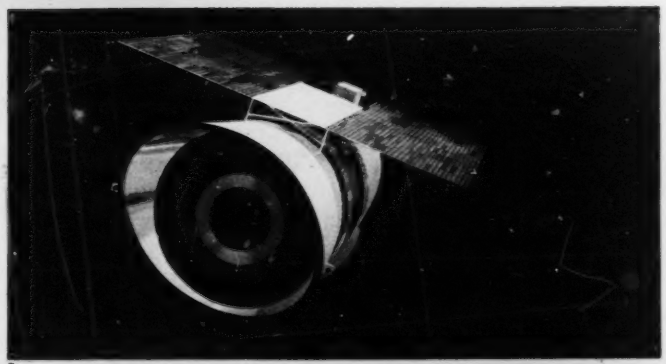
6. Slated for launch this year is NASA's Tracking and Data Relay Satellite, two of which will provide Shuttle-era communications between spacecraft and Earth bases.

7. In development is the Defense Satellite Communications System-III, whose king-size satellites will expand the military communications capability.

8. In development and planned for 1982 launch is Landsat D, fourth and most advanced member of the resources-monitoring satellite family.

9. To be launched this year, the Infrared Astronomical Satellite will survey infrared sources in the universe.

10. Artist's concept shows deployment of the Space Telescope – scheduled for service in 1985 – which will peer seven times further into space than ground-based telescopes.



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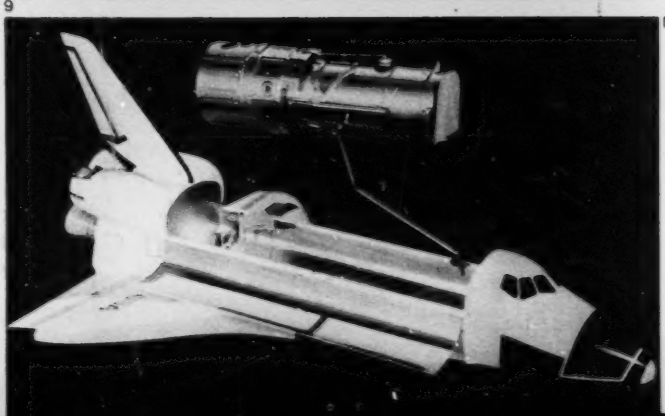

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Civil Aviation

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1. The Boeing 767 jetliner made its initial flight in September.
2. In production and scheduled for first flight in February 1982 was the Boeing 757.
3. In August, McDonnell Douglas started deliveries of the DC-9-82, latest model of the Super 80 series.
4. In September, McDonnell Douglas began flights of a winglet-equipped DC-10 to test fuel-efficiency gain.

4

After record financial losses in 1980, the U.S. airline industry had another disappointing year in 1981 and looked for little improvement in 1982. According to the Air Transport Association, the industry's poor financial performance is expected to cause a short-term decline in orders for new commercial aircraft, but there remains a large-scale demand for new planes to take advantage of the latest advances in fuel efficiency and other areas of aircraft productivity.

Financial details were not available at year-end, but ATA preliminary estimates indicated that the scheduled airlines would experience another loss on some $36 billion of revenues. With the outlook for 1982 dim, it seemed likely that the 1979-82 four-year financial record of the industry would be the worst in history.

On a more positive note, ATA member airlines completed two years without a fatality at the end of October. During the two years, the airlines carried more than half a billion passengers on 10 million flights and produced 13 billion ton miles of cargo service.

In 1981, the airlines operated five million flights. Passenger service declined by an estimated three to four percent. Air cargo began showing gains in the last half of the year and ATA estimated that there would be only a slight decrease from the 7.1 billion ton miles produced in 1980. With continuing gains throughout the year, mail was a bright spot in the cargo market. For 1982, passenger traffic is expected to rise by about five percent and air cargo should also show improved performance.

In the commercial transport manufacturing segment of the aerospace industry, a highlight of the year was the September 26 first flight of the Boeing 767 jetliner. The flight marked the start of a 10-month test program aimed at certification and first deliveries of the twinjet in the summer of 1982. The companion Boeing 757 was in production at year-end, with initial flight scheduled for February and certification expected in December 1982.

In August, McDonnell Douglas received certification of the DC-9-82, latest model of the advanced technology Super 80 series, and deliveries of the -82 began in the same month. In September, the company inaugurated tests of a DC-10 equipped with winglets

5. The Lockheed L-1011 TriStar will be phased out of production in 1984, the company announced in December.
6. Boeing Vertol started deliveries of the Model 234 helicopter, which was introduced to commercial service in July by British Airways Helicopters.
7. Bell Helicopter Textron's Model 412 transport became operational during the year.
8. The fleet of Sikorsky S-76 transport helicopters grew to 166 aircraft operating in 26 countries.
9. A highlight of the NASA/Army XV-15 Tilt Rotor Research Aircraft test program was a 1,600-mile cross-country flight in October.
10. NASA completed a 38-flight test program of the AD-1 Oblique Wing Research Aircraft.

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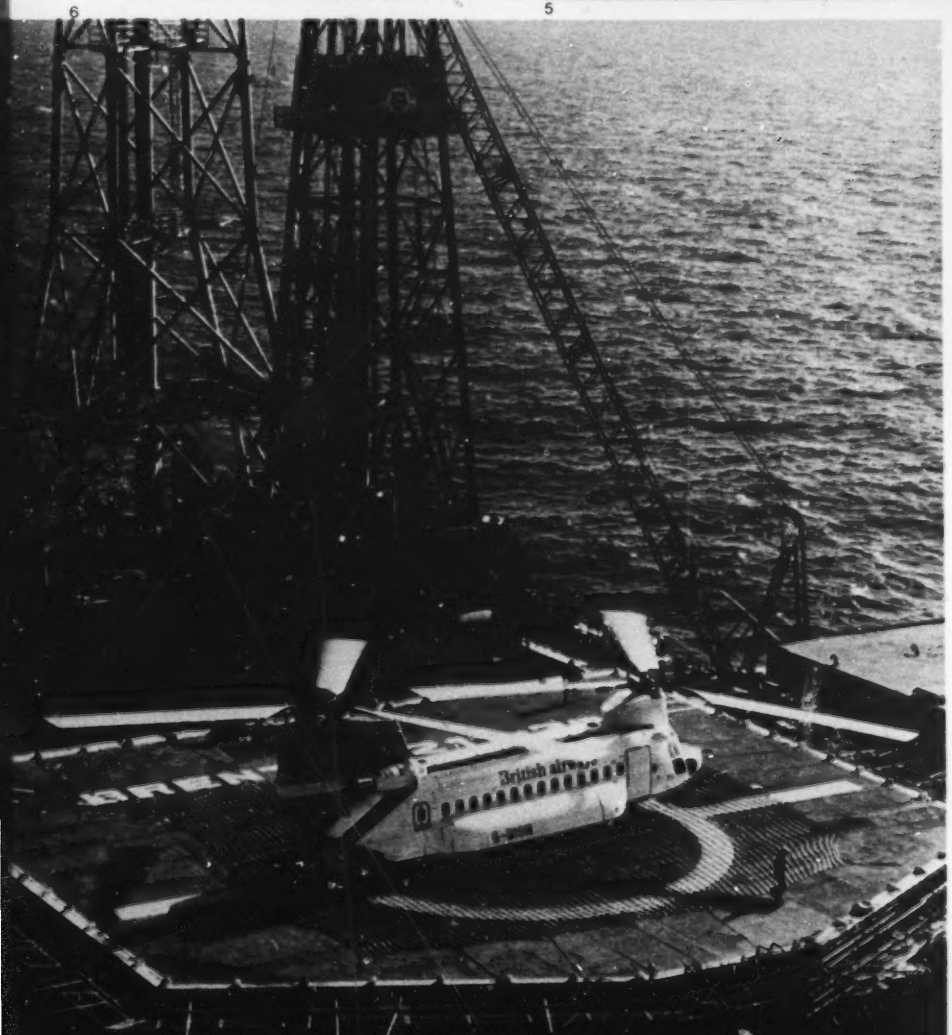

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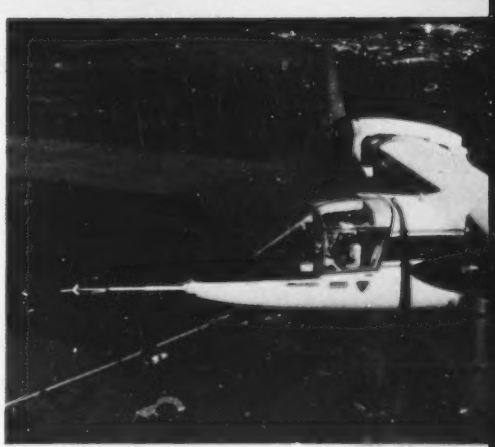
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to determine the degree to which these airfoils contribute to increased fuel efficiency. In May, McDonnell Douglas and the Dutch Fokker company announced plans for joint development of a 150-seat airline transport designated MDF-100.

Lockheed continued deliveries of the L-1011 TriStar but in December announced plans to phase out production; the last of the trijets will be delivered in 1984.

U.S. commercial transport manufacturers delivered 395 aircraft in 1981, 12 more than in 1980; their dollar value was $9.8 billion, down from $9.9 billion in the previous year. Sales of U.S.-built civil helicopters amounted to $573 million, down from $656 million in 1980.

In1981 rotary wing activity,

- Boeing Vertol began deliveries of the Model 234 44-passenger civil transport helicopter and British Airways Helicopters inaugurated service in July.
- Bell Helicopter Textron made first deliveries of the four-bladed Model 412 transport helicopter and by year-end 50

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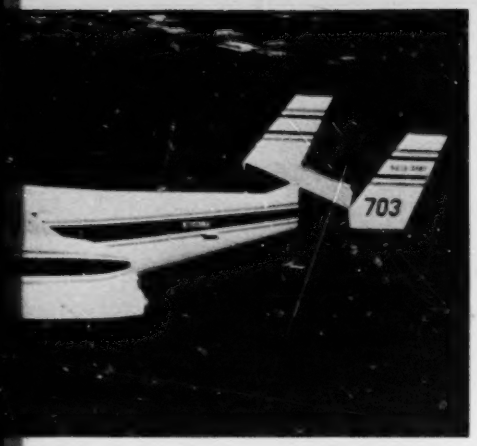

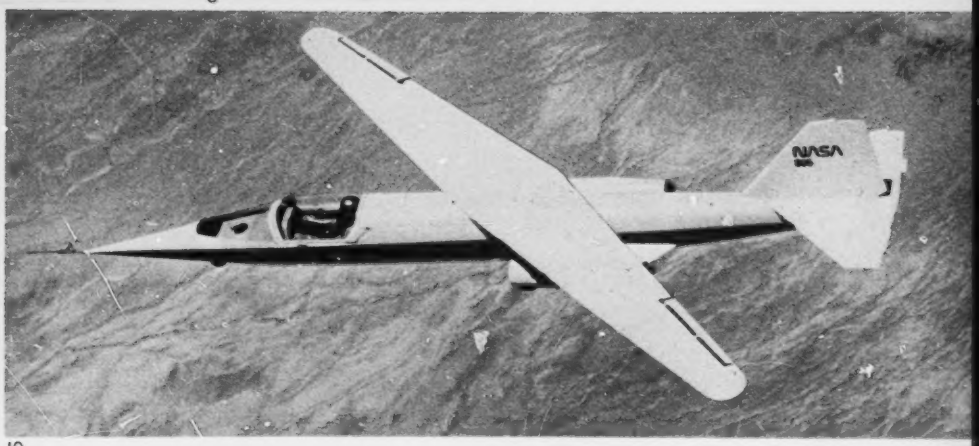

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aircraft were operational, the majority of them in petroleum support service.

• Production continued on Sikorsky Aircraft's S-76 twin-turbine transport and by the end of the year the S-76 fleet included 166 aircraft in 26 countries. Sikorsky forecast a production run of 1,600 S-76s over the next 15 years.

In rotorcraft research, a highlight of the year was the October 1,600-mile cross-country flight of the NASA/Army XV-15 Tilt Rotor Research Aircraft, built by Bell Helicopter Textron. Testing of the No. 2 XV-15 continued at NASA's Ames Research Center; the No. 1 aircraft was returned to Bell's plant for modifications and further company testing.

NASA continued flight testing of the Sikorsky-built Rotor Systems Research Aircraft, a flying laboratory for investigations of various rotors applicable to either helicopters or compound helicopters. Also undergoing test by Sikorsky was the company's ABC (Advancing Blade Concept) helicopter.

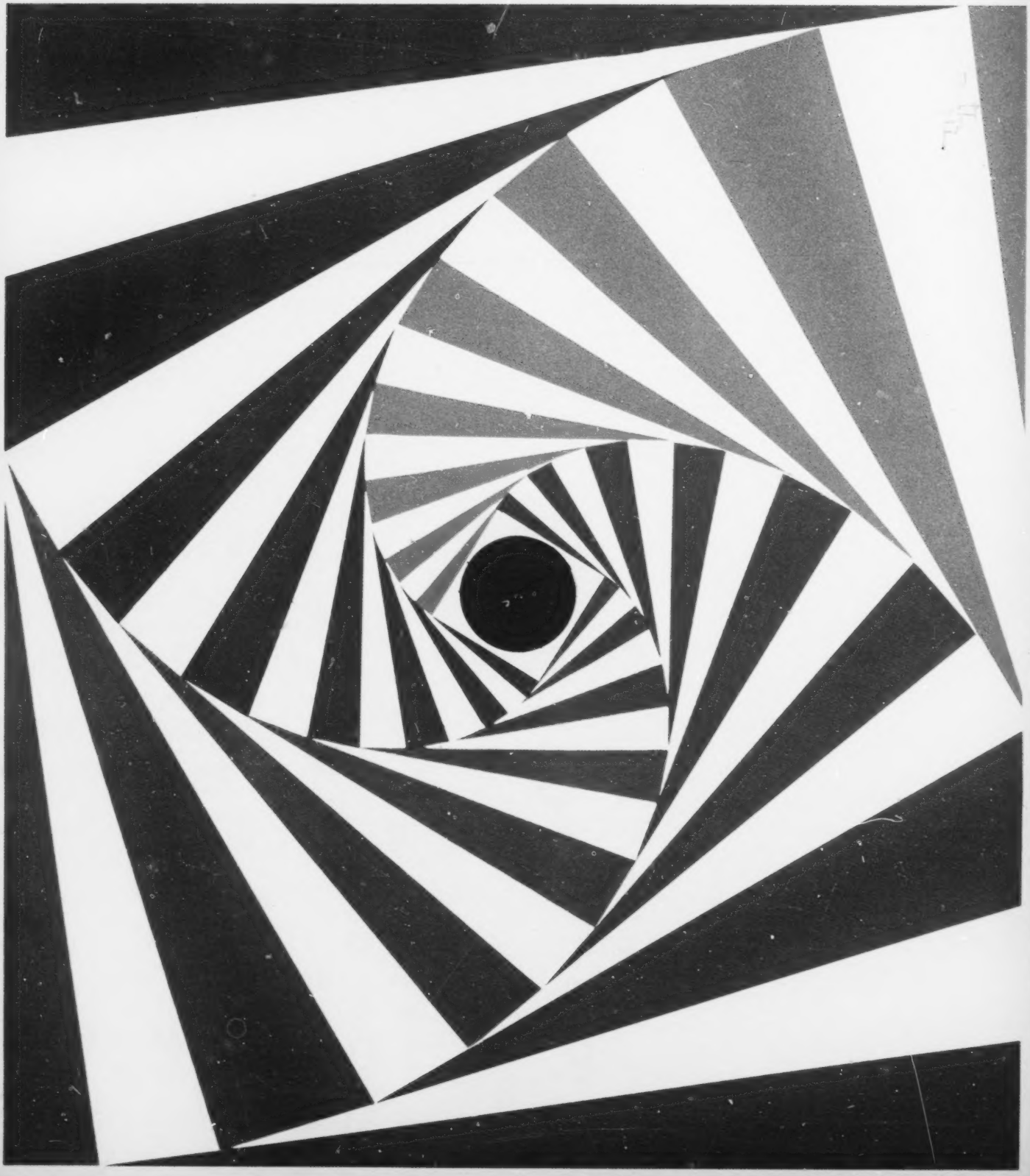
In other NASA research, a 38-flight test program of the AD-1 Oblique Wing Research Aircraft was completed. The craft, whose wing can be pivoted in flight, was successfully flown at wing angles up to 60 degrees in a first step toward validating the concept that wing-shifting can increase aerodynamic efficiency in the higher speed ranges while maintaining efficiency at low speed. NASA also continued tests of the Boeing-built Quiet Short-haul Research Aircraft, designed to demonstrate the propulsive lift concept which may enable tomorrow's short-haul transports to operate from very short runways.

The Federal Aviation Administration continued to upgrade its Third Generation Air Traffic Control System. Following last year's commissioning—at the Cleveland Air Route Traffic Control Center—of the first En Route Minimum Safe Altitude Warning System (E-MSAW), FAA was preparing to install E-MSAW at the Chicago and Kansas City centers. E-MSAW monitors the flight path of aircraft equipped with altitude-encoding transponders for adequate clearance of terrain and man-made obstructions by comparing the plane's path with a computer-stored grid map of the terrain. Eventually, E-MSAW systems will be installed at all 20 Air Route Traffic Control Centers in the contiguous 48 states. A similar system is already operational at the 62 terminals equipped with ARTS III automated radar systems.

FAA started installations of a more sophisticated ARTS IIIA, developed by Univac Division of Sperry Rand. Like the ARTS III, the new system has a conflict alert capability for warning controllers when aircraft are on converging courses. When the system detects a conflict, it activates a buzzer and flashes the letters "CA" on the controller's radar display. The controller instructs pilot to take action to avoid the potential danger.

During fiscal year 1981, FAA obligated $450 million in airport grants under the Airport Development Aid Program. Included were 56 planning grants, 368 grants to air carrier airports, 50 to commuter airports and 163 to general aviation airports.

AEROSPACE REVIEW AND



FORECAST 1981/1982

In 1981, the aerospace industry recorded new statistical peaks in sales, exports and contribution to the U.S. trade balance, but experienced a decline in year-end backlog for the first time in six years. Here is a summary of the industry's performance, based on preliminary estimates which will undergo refinement in coming months:

Sales. Total industry sales amounted to $61 billion, compared with $53 billion in 1980. The increase represents a gain of 14.3 percent or a real growth—above the rate of inflation—of about five percent.

As in the previous year, the largest increment of gain was in sales of aerospace products to the Department of Defense, which amounted to $24 billion, some $4.6 billion higher than in 1980. However, commercial sales also increased by more than $3 billion, to a 1981 figure of $23.7 billion.

In the interests of perspective, it is the industry's practice to compare each year's sales volume with that of the all-time peak year—1968—by converting sales figures to inflation-adjusted constant dollars. On that basis, 1981 sales were about 10 percent below those of the peak year but higher than in any other year of the industry's history except the near-peak year 1967.

Backlog. Orders on the industry's books at year-end 1981 amounted to $92.1 billion, down three percent from 1980's $95.4 billion. This was the first backlog decline since 1975 and it was due to lagging orders for commercial transport aircraft (down eight percent). Nonetheless, commercial business still constituted more than half of the total backlog.

Exports/Trade Balance. Reflecting continuing strong demand abroad for U.S. aerospce products, exports were up 16.8 percent to a 1981 total of $18.1 billion, an all-time high. Aerospace imports also reached a record $4.3 billion. Despite the increase in imports the aerospace trade balance rose during 1981 some 16 percent to more than $13.8 billion, also a record level.

Earnings. Profit after taxes, measured as a percentage of sales, matched the previous year's 4.3 percent. The figure compares with a 1981 average for all U.S. manufacturing industries of 4.6 percent.

Plant and Equipment. Aerospace expenditures for new plant and equipment declined to $6.5 billion, 7.4 percent below the all-time peak outlays of $7 billion in 1980. A number of economic factors—such as business uncertainty, high interest rates and tight profit margins—influenced the decline.

Employment. Aerospace industry employment rose about one percent to 1,229,000. Annual payroll increased some 10 percent to $31.7 billion.

Summary. The aerospace industry's activity curve, as measured by constant dollar sales volume, continued the upward climb initiated in 1976.

FORECAST

A significant trend is evident in 1981 aerospace sales and backlog figures: the defense portion of the industry's workload is growing more rapidly than commercial business, a complete turnaround from the experience of the late 1970s when commercial sales grew faster and topped DoD sales in 1979 and 1980. There are two principle reasons: the military force buildup initiated in the last year of the Carter Administration and continued in 1981, and the uncertain financial health of the airline industry, which has caused deferments of new transport orders and deliveries.

For 1982, overall industry sales are estimated at $66.6 billion, about nine percent above 1981. The forecast assumes a decline in commercial sales of aerospace products—the first since 1972—to $21 billion. Defense sales are expected to increase sharply to almost $31 billion. Moderate increases are projected for sales to NASA and other agencies, and non-aerospace sales by aerospace manufacturers should also increase. The industry's employment will increase 2.9 percent to a total labor force of 1,265,000, with an attendant payroll increase of 11 percent, to $35.2 billion.

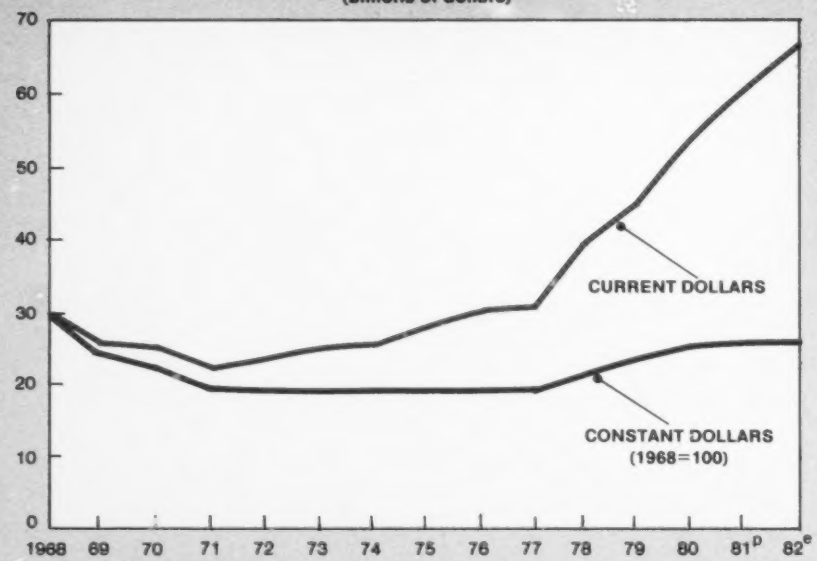
The outlook for years beyond 1982 is clouded by uncertainties, but here is the industry's general view of the remaining years of the decade:

Defense. If Congressional appropriations continue to support the Administration's defense plans, the aerospace industry's workload in defense research, development and production should increase substantially throughout the 1980s.

Space. Current and projected NASA budgets indicate declining aerospace industry activity in NASA areas other than Space Transportation System operations and development. The loss of NASA business will be offset by increasing defense space outlays and by growing commercial space business—communications systems, for example. For the years through 1985, the industry's overall space workload should remain at approximately the current level. The broad potential of the Space Shuttle offers new opportunities for beneficial space operations and suggests the possibility of a revivified space program in the latter years of the decade, given an upturn in the national economy.

Commercial. Transport aircraft constitute the largest element of the industry's commercial sales and latest projections indicate a $125 billion transport market between now and 1992. Such projections assume resumption of airline traffic growth and improvement in the airlines' financial status. The U.S. share of the world market will probably decline to some degree as a result of strong and growing competition from foreign manufacturers. For the near term, the industry expects transport sales to dip somewhat below the 1981 all-time peak level. In the longer term, sales volume could top that level if market projections prove accurate. Similarly, business prospects are good for helicopters and business jets, if American companies can offset the competitive disadvantage of low financing rates offered by government-subsidized foreign producers.

AEROSPACE INDUSTRY SALES
(billions of dollars)

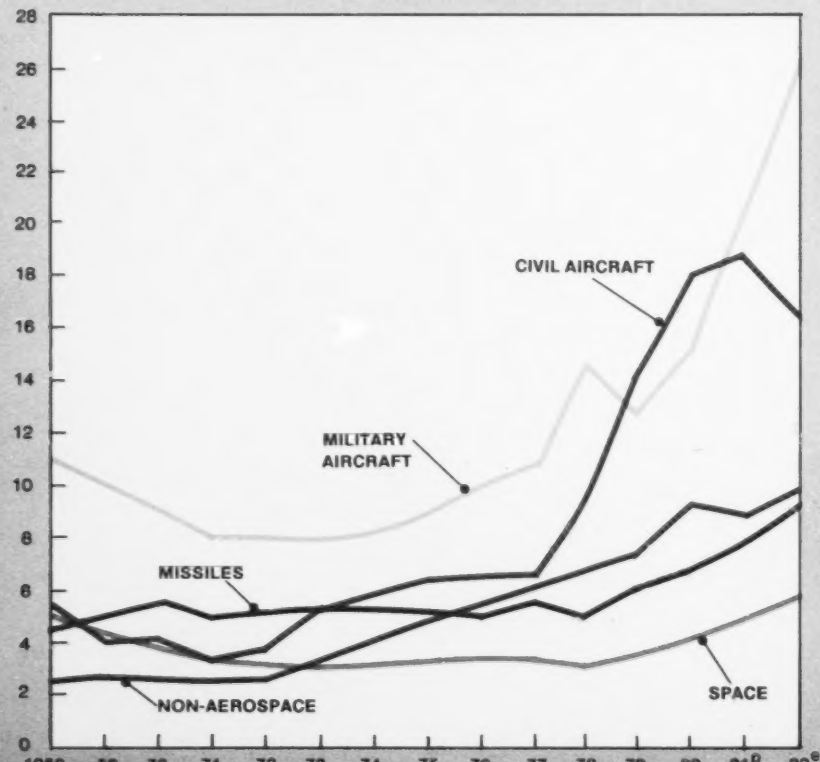


Source: Aerospace Industries Association

p—Preliminary
e—Estimate

The aerospace industry's 1981 total sales of $61 billion included $52.5 billion in sales of aerospace products and services, plus $8.5 billion in non-aerospace products. Sales to government agencies, at $33.2 billion, amounted to 54 percent of the total. For 1982, overall sales are estimated at $66.6 billion, up nine percent. Due to lagging commercial activity, government sales are expected to rise to 62 percent of the total.

AEROSPACE INDUSTRY SALES BY PRODUCT GROUP
(billions of current dollars)



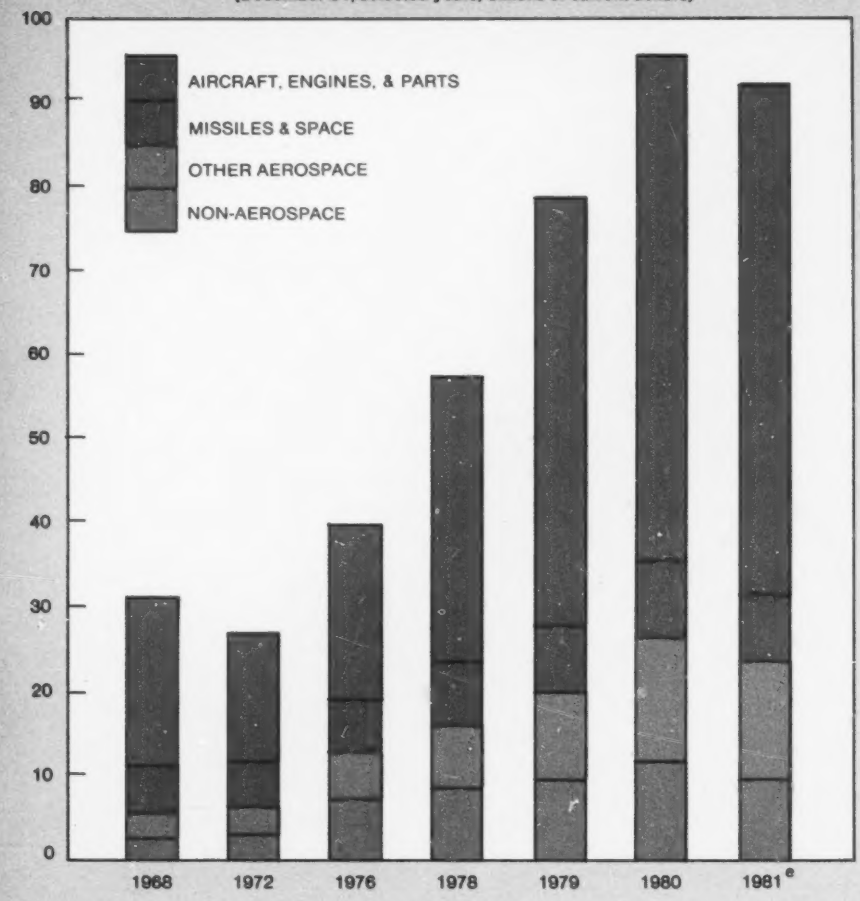
Source: Aerospace Industries Association

p—Preliminary
e—Estimate

As is traditional, aircraft production represented the largest single element of the 1981 sales volume—66 percent. Sales of military aircraft topped civil aircraft sales for the first time since 1978, increasing by 37 percent while civil aircraft sales gained only eight percent. In 1982, military aircraft sales are expected to grow by 27 percent while civil aircraft sales decline by 16 percent.

AEROSPACE INDUSTRY BACKLOG, BY PRODUCT GROUP

(December 31, selected years; billions of current dollars)



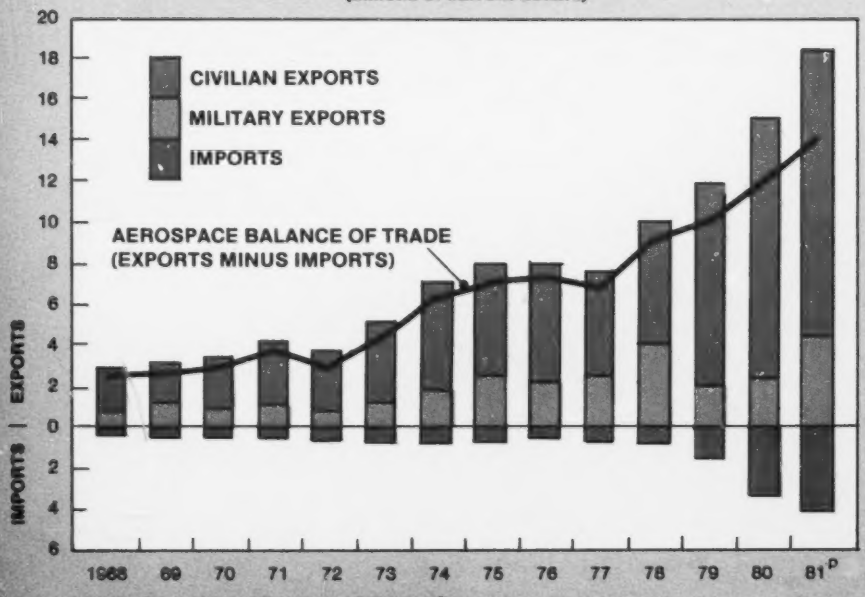
Source: Department of Commerce Data, AIA Forecasts
e—Estimate

The industry's backlog of orders at year-end 1981 was $92.1 billion, down three percent from the$95.4 billion on the books at the end of the previous year. Although commercial orders were down eight percent, they still made up more than half the backlog.

Aircraft, engines and parts constituted 65 percent of the total backlog. A breakdown of other backlog shows 15 percent for "other aerospace" products, 11 percent for non-aerospace products, and nine percent for missile and space systems.

AEROSPACE EXPORTS, IMPORTS, AND TRADE BALANCE

(billions of current dollars)



Source: Department of Commerce Data, AIA Forecasts
p—Preliminary

The 1981 aerospace export sales volume rose 16.8 percent to a record $18.1 billion. Real growth, above the rate of inflation, was 7.1 percent. The aerospace trade balance increased by 16 percent to more than $13.8 billion, also a peak level; adjusted for inflation, the gain was more than six percent. The growing strength of foreign competition was evidenced in a 20 percent increase in aerospace imports, which amounted to $4.3 billion.

Civil aerospace exports continued to be the largest element of the export volume, but military exports showed a sharp rise of almost $2 billion, or 87 percent. Civil exports constituted 77 percent of the total, down from 85 percent in 1980.

CIVIL AIRCRAFT SHIPMENTS

1968-1982

Year	NUMBER OF AIRCRAFT SHIPPED				VALUE (Millions of Dollars)			
	TOTAL	Commercial Transport Aircraft	Helicopters	General Aviation	TOTAL	Commercial Transport Aircraft	Helicopters	General Aviation
1968	14,922	702	522	13,698	$ 4,267	$3,789	$ 57	$ 421
1969	13,505	514	534	12,457	3,598	2,939	75	584
1970	8,076	311	482	7,283	3,546	3,158	49	339
1971	8,158	223	469	7,466	2,984	2,594	69	321
1972	10,576	227	575	9,774	3,308	2,660	90	558
1973	14,709	294	770	13,645	4,685	3,718	121	826
1974	15,326	332	828	14,166	5,091	3,993	189	909
1975	15,251	315	864	14,072	5,086	3,779	274	1,033
1976 (r)	16,429	222	757	15,450	4,592	3,078	285	1,229
1977 (r)	17,913	155	848	16,910	4,451	2,649	251	1,551
1978 (r)	18,962	241	904	17,817	6,458	4,308	328	1,822
1979 (r)	18,450	376	1,019	17,055	10,644	6,030	403	2,211
1980	13,634	387	1,366	11,881	13,058	9,895	656	2,507
1981 (p)	11,143	395	1,073	9,675	13,135	9,762	573	2,800
1982 (e)	10,446	274	1,172	9,000	10,811	7,186	625	3,000

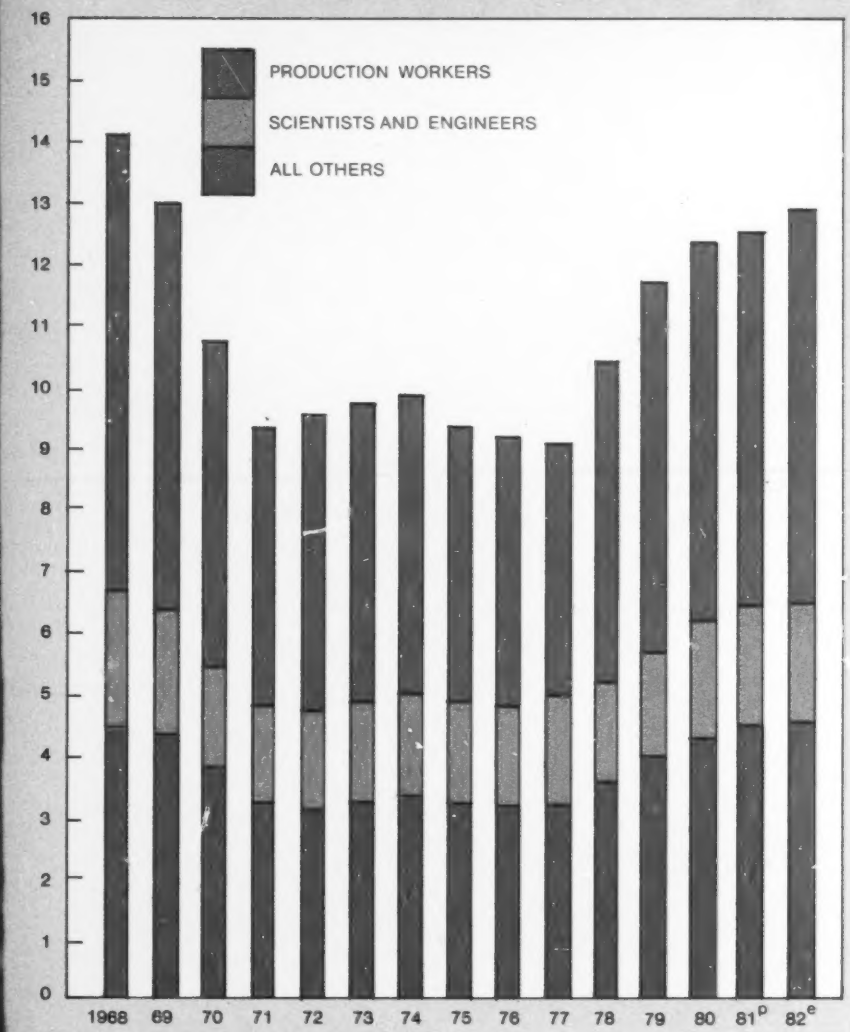
Source: Aerospace Industries Association and General Aviation Manufacturers Association.
(r) Revised.
(p) Preliminary.
(e) Estimate.

Sales of civil aircraft totaled $13.1 billion in 1981, a slight increase over 1980. In terms of numbers, however, civil aircraft shipments declined some 18 percent to 11,143 units. The higher value of fewer shipments is due to a higher average unit price occasioned by inflation and by delivery emphasis on higher-priced aircraft in the general aviation and helicopter categories.

Commercial transport deliveries accounted for 74 percent of the sales volume but only four percent of unit shipments. Transport shipments, at $9.8 billion, were down from $9.9 billion in the previous year; the estimate for 1982 indicates a sharper decline to $7.2 billion. General aviation shipments dropped more than 2,000 units but sales value increased some $300 million to $2.8 billion; a seven percent decline in shipments is forecast for 1982, but value will increase to $3 billion. Helicopter deliveries declined by almost 300 units and dollar value also dropped, from $656 million in 1980 to $573 million in 1981; for 1982, the helicopter sales projection indicates a gain in unit deliveries (up 100) and in value (up $52 million).

AEROSPACE EMPLOYMENT

(hundreds of thousands of employees)

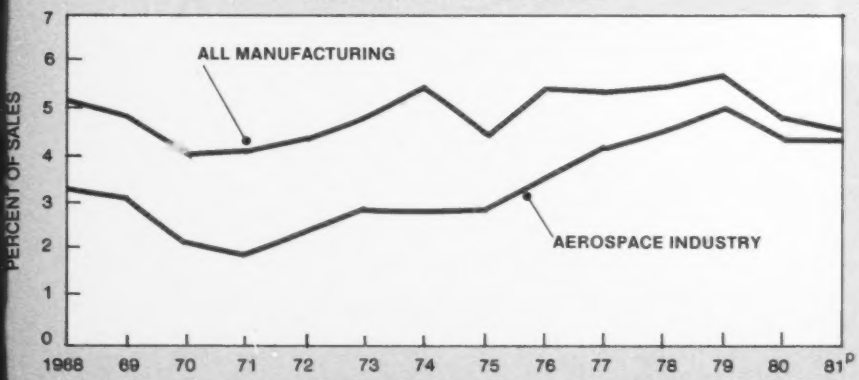


Source: Aerospace Industries Association
p—Preliminary
e—Estimate

Aerospace industry employment reached its highest level since 1969, increasing about one percent to 1,229,000. The number of production workers declined more than two percent, but there were offsetting increases in scientists/engineers and in "all others" category. An employment growth of 2.9 percent, to a total of 1,265,000, is forecast for 1982.

The annual aerospace payroll reached an all-time high of $31.7 billion in 1981 and estimates for 1982 indicated a further increase of 11 percent, to $35.2 billion.

NET PROFIT AFTER TAXES



Source: Federal Trade Commission and AIA estimates.
p—Preliminary

The industry's 1981 profit after taxes, measured as a percentage of sales, was 4.3 percent, the same as in the previous year and well below the 1979 peak of five percent. The 1981 figure compares with 4.6 percent for all U.S. manufacturing industries. In dollar terms, the aerospace profit was $3.1 billion, up some $540 million from the 1980 level.

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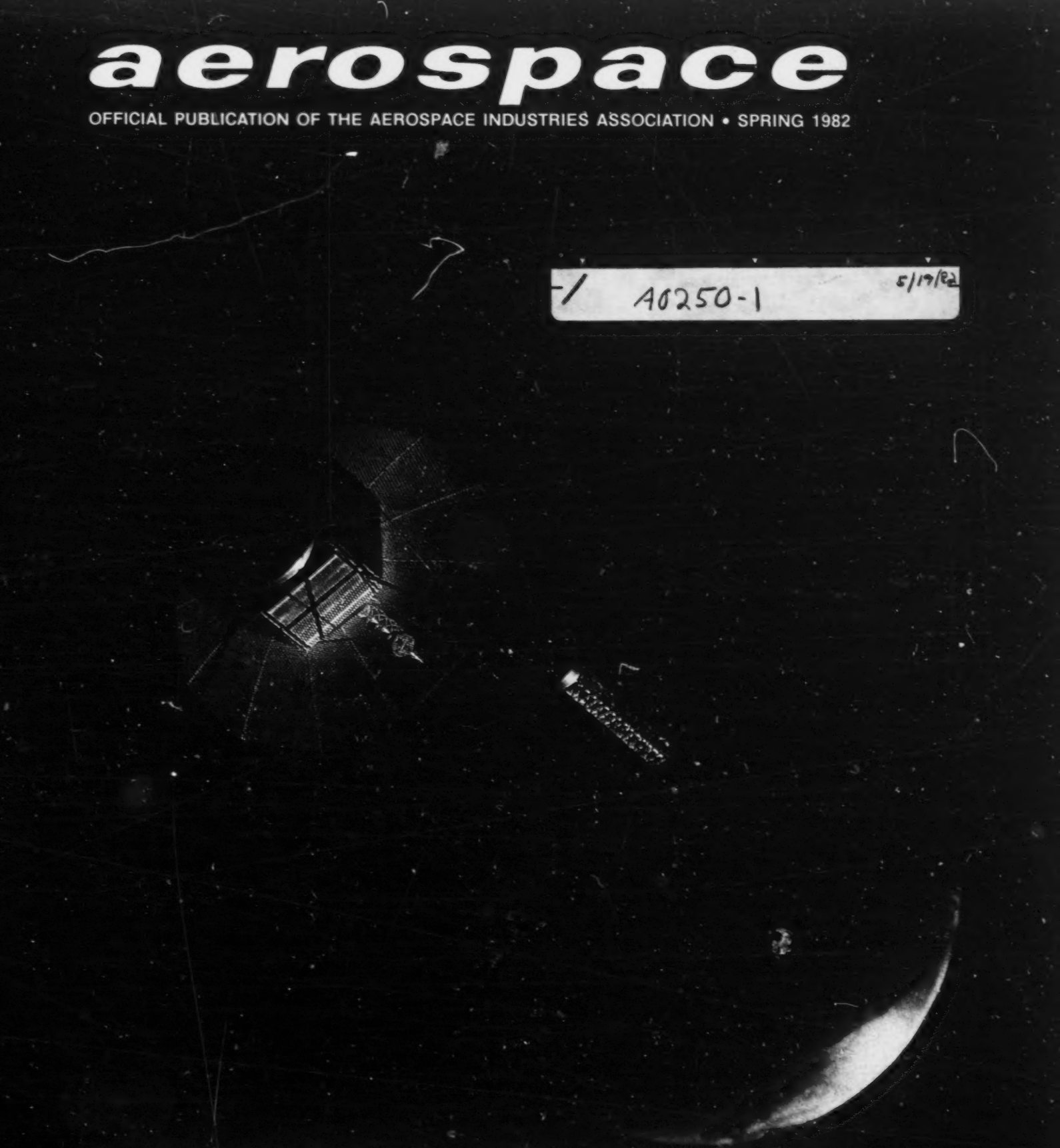

MILITARY IN SPACE

By STUART E. EIZENSTAT

Chief domestic advisor to President Carter in 1977-81, Mr. Eizenstat now practices law in Washington, D.C. and does a significant amount of work involving the Export-Import Bank.

EXIM BANK: A WISE INVESTMENT

What federal program has been fully self-sustaining, made a profit for the Treasury for over 40 years, been recommended by Congress' watchdog agency for increased flexibility and additional resources, promoted the sale of U.S. goods against foreign competition, created American jobs without using a nickel of appropriated money—but is being cut deeply by the Administration's budget office and now has to fight for its life? The answer is the Export-Import Bank of the United States (Exim Bank), one of the least understood but most important organizations in the federal government.

The Exim Bank operates under a mandate from Congress to provide competitive financing for U.S. exports. While not statutorily required to be self-sustaining, it has operated in a self-sustaining fashion since its creation. With a capitalization of $1 billion in 1945, it has accumulated an income reserve of $2.2 billion and has paid $1.05 billion in dividends *back* to the Treasury. It is ironic that Exim Bank should even be the subject of a budget fight in light of its money-making history. Traditionally, the cost of its loans, loan guarantees, and insurance programs are more than matched by loan repayments, interest on its loans, insurance premiums, and fees from its users. It has assisted more than $100 billion in exports of products made by American workers in America.

At a time of high unemployment, it is important to recognize that exports are highly job-creating. Every $1 billion of exports of manufactured goods supports 30,800 jobs in the U.S., and one in every seven American workers is involved in the production of manufactured goods sold abroad. Using Bureau of Census figures, Exim Bank's 1980 operations supported over 570,000 American jobs, and over 11 million man-years of employment in the last three years. The cuts in Exim funding now before Congress could mean a reduction of billions of dollars in export sales and hundreds of thousands of man-years of employment over the next five years.

Exim Bank is not without its problems. Soaring interest rates on the money it borrows have cut deeply into its net income. While it has still earned a net income because of its interest earnings on its reserves, it may well have a net loss this year for the first time. But this is because the impact of extraordinarily high interest rates has caused an abnormally high negative spread between its cost of borrowing and its lending rates—not due to any inherent flaw in the Bank's structure. The solution for these problems is to strengthen the Bank, not further weaken it. As interest rates drop, Exim Bank should begin to return to a positive earnings position.

The Bank makes money for the Treasury far beyond its costs. This was graphically demonstrated in a recent study which found that, on one project submitted for Exim Bank financing, the U.S. government would get back nine times more in receipts—due to increased economic activity and jobs—than the cost of its loans.

Foreign Competition

Other industrialized nations have government programs to finance their exports—but with an intensity that has far outpaced Exim Bank. A recent study by the Comptroller General of the United States found that Japan and the United Kingdom officially supported 35 percent of their exports with export incentives, France 29 percent, Germany 12 percent, and the United States only six percent.

As American companies compete head-to-head with foreign companies for world markets, the competition is increasingly unfair. Contrary to popular myth, American enterprise can compete favorably in price, quality, and service with goods produced in other industrial nations—but not with foreign *governments* which heavily subsidize the financing for their exports. These financing terms are often the critical factor in whether a sale is made by an American or a foreign firm.

One of the reasons foreign goods have penetrated so deeply into our own domestic market is foreign export financing available to foreign exporters shipping to the United States. Thus, American airline companies have purchased the European Airbus, rather than U.S.-made aircraft, in part because of the more favorable credit terms provided by the foreign manufacturers. U.S. aircraft manufacturers have lost a considerable share of a world market in which they had been dominant, in significant part due to foreign export financing which U.S. companies cannot match.

European countries and Japan have long recognized that to survive economically they must place a priority on exports, since their internal markets are small and their natural resources limited. The Government Accounting Office found that unlike Exim Bank, some of its foreign counterparts receive operating subsidies from their government, can finance foreign components of a project, "provide insurance against cost escalations and currency fluctuations, and offer other sweeteners to make their financing more attractive."

The United States, on the other hand, has relied so long on its huge domestic market and the technical superiority of American goods which prevailed in the immediate post-World War II era, that exports were assigned a lesser priority by the private and public sectors. If we could ever afford the luxury of such a insular view, that time has passed. Exports must become a major priority for the United States, and with this must come a concomitant commitment to strengthen the institution

best able to promote U.S. exports and to put them on a competitive footing with foreign subsidized exports—Exim Bank. To engage in competition with a weakened Exim Bank is to attempt to win with our best hand tied behind our back.

Critics' Objections

It is argued that Exim Bank is "corporate welfare" for a few large U.S. exporters. This is incorrect. Exim Bank has made commitments to more than 5,700 firms, small and large, in all 50 States. While the large exports for which many big American companies compete do take up a significant part of Exim's borrowing authority, these exports are in the manufacturing sector this country so desperately needs to strengthen; they involve thousands of small suppliers and subcontractors who make or supply component parts for these exports and who benefit from Exim financing as much as the direct exporter.

What is more, this is hardly "corporate welfare." U.S. exporters are simply given the opportunity to offer to their prospective foreign purchasers financing terms competitive with those offered by other countries. The loans are repaid with interest and the American company pays a fee for participating—some welfare!

A second argument is that Exim Bank amounts to government intervention in the private capital marketplace. Certainly no one wishes more devoutly to be able to charge their purchasers market prices for financing than U.S. exporters—provided foreign countries do the same by ending their export subsidies. There is no free market in export financing so long as our trading competitors so regularly and fiercely engage in export subsidization.

The last fallacious argument made by the Bank's critics is that is does not really finance sales that would otherwise be lost. This has been proven incorrect. The Government Accounting Office surveyed 117 exporters who had applied to Exim Bank for export assistance but were either denied direct loan assistance or did not use it. The GAO specifically documented many lost sales worth hundreds of millions of dollars due to lack of competitive financing. In 1980, the Treasury Department reported that more than 70 percent of the direct credit export sales financed by Exim would not have been made without such financing.

A New Development

On February 23, 1982, a new organization was established: the Coalition for Employment Through Exports (CEE), made up of corporate exporters, governors from several states and the international presidents of six major trade unions. CEE is a tangible manifestation of the cooperation between government, business, and labor that has been previously lacking in the export area. It is a recognition of the central importance of exports to economic growth, job creation, and to ending the recession—and of Exim Bank's critical importance to exports. CEE has made its top priority educating Congress and the Administration to the need for enhanced resources for the Exim Bank.

The renewed business and labor activity for Exim Bank could hardly have occurred at a more timely occasion. Exim means jobs at a time of recession; more exports at a time of high trade deficits; additional revenues from expanded growth at a time of budget deficits; meeting foreign exports at a time of intense international trade competition. It deserves America's support—now more than ever.

This guest editorial was excerpted from an article in *Government Executive* magazine.

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Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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MILITARY IN SPACE

BY JAMES J. HAGGERTY

"The Soviet goal of having continuously manned space stations may support both defensive and offensive weapons in space, with man in the space station for target selection, repairs and adjustments, and positive command and control." So says *Soviet Military Power*, a hundred-page report prepared by the U.S. Department of Defense. It adds that the U.S.S.R. is developing a super-powerful space booster with six to seven times the launch capability of the American Space Shuttle, and that this booster will be capable of putting very large space stations in orbit. In recent Congressional testimony, a Defense official went a step further and predicted that a permanent Soviet space station could be in operational service "about 1990."

Soviet Military Power sounds other warning notes. It estimates that 70 percent of all Soviet space systems serve purely military purposes and that another 15 percent have dual civil/military roles. For the past 10 years, the U.S.S.R. has been launching about 75 spacecraft a year, four to five times the U.S. rate, with payload weights totaling 10 times the U.S. figure. The Soviets are actively developing antisatellite interceptors and laser weaponry, and they are lavishing a lot of rubles on buildup of their space research, development, production and

1. The artist's conception depicts the military Space Shuttle launch complex at Vandenberg Air Force Base, California as it will look when it becomes operational in 1985.
2. Principal expendable booster for military space payloads is the Titan III launch vehicle.

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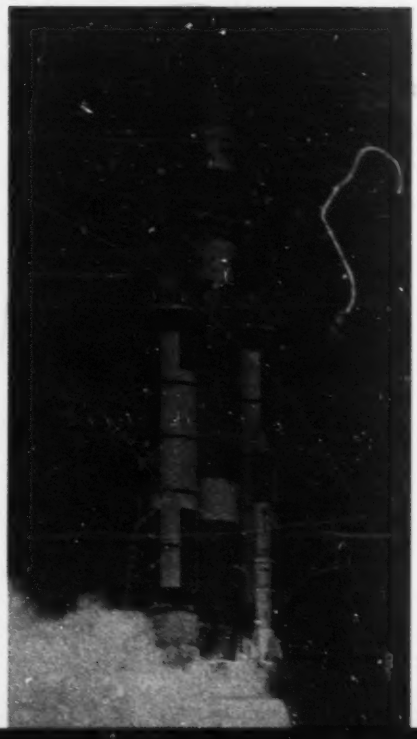
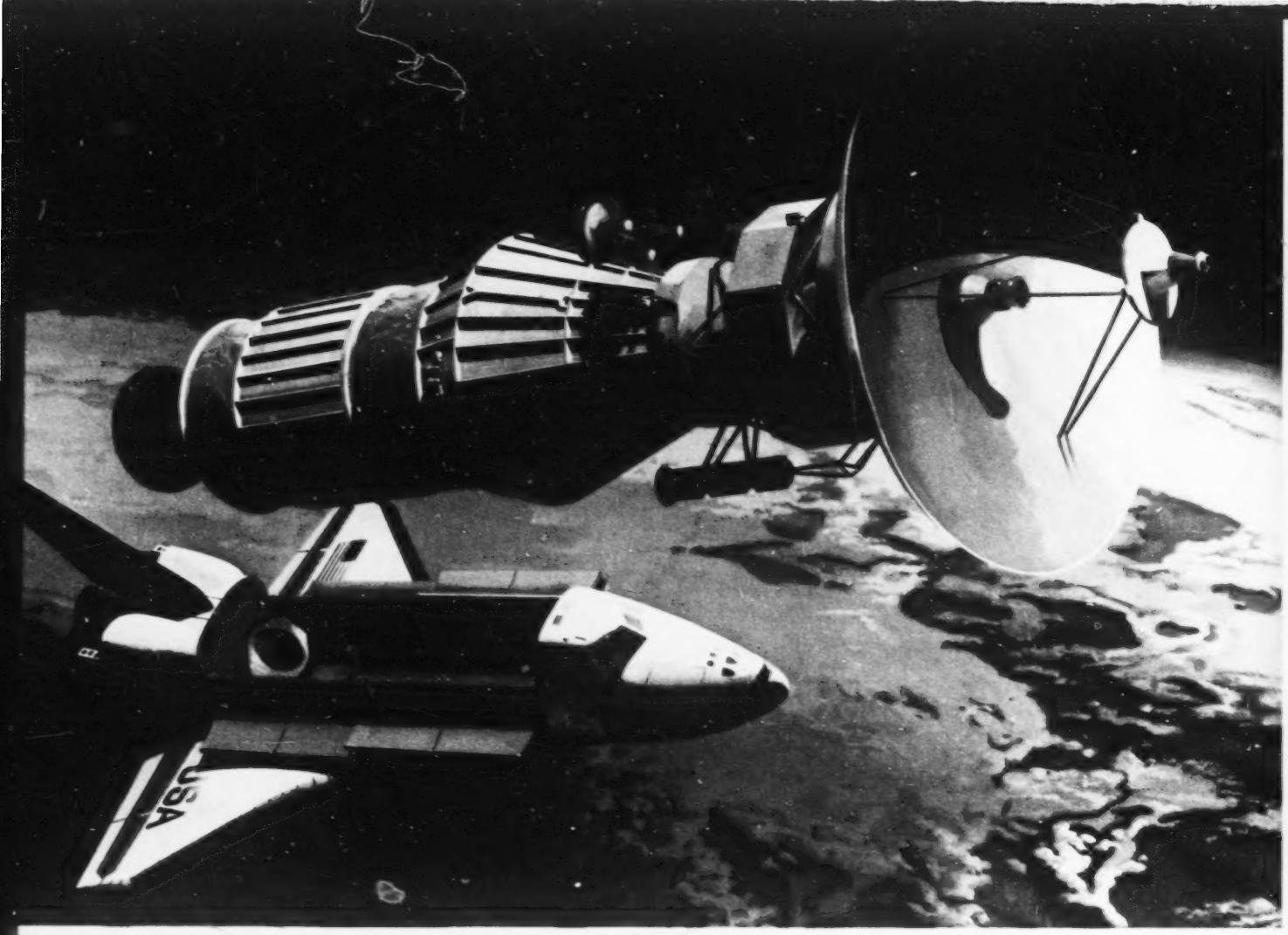




launch facilities. The report continues: "The Soviets' predominantly military space program is expected to continue to produce steady gains in reliability, sophistication and operational capability."

All of which prompts the questions: How about our own military space capability? Are we lagging here as in other areas of defense?

The answer is that the U.S. has a lot of research and development to accomplish if it is to match the capability the Soviets are apparently planning—but so does the Soviet Union. Much of the U.S. R&D is already in progress but in some instances it is still in the study phase. Generally speaking, the U.S. is not lagging; the Department of Defense has developed a solid foundation for space operations, although the effort has attracted little public attention because much of it is secret and the unclassified parts do not inspire headlines.

DoD has operational systems in two unmanned spacecraft categories: intelligence collecting satellites and defense support satellites. There is, in addition an operational ground-based spacewatch system for keeping track of objects in orbit—ours and theirs. The Air Force—which handles most of DoD's space development and operations—will have a manned space capability with the start of military Space Shuttle flights and NASA is now training USAF people for mission planning, flight control and Shuttle crew assignments.

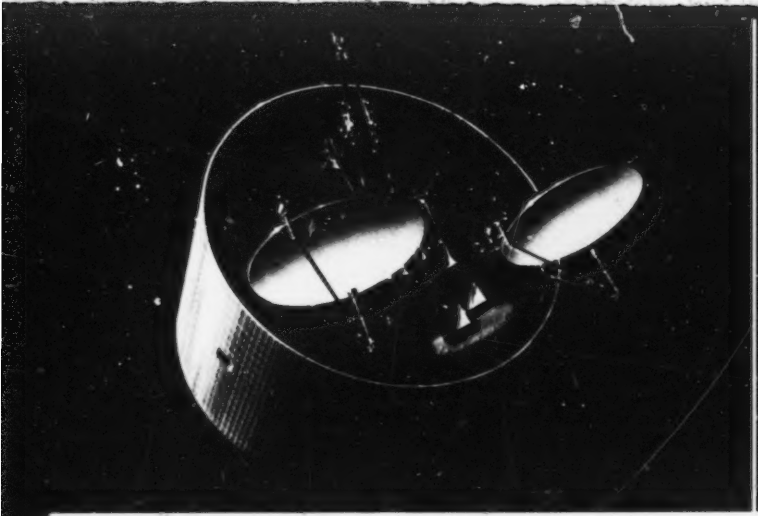
Money is usually a good indicator of activity and the DoD space funding pattern for the past decade suggests that the hierarchies of several Administrations have been well aware of the space threat and potential. Where the defense budget in general declined during the seventies, space money went up; it has increased in every year since 1972 and the boosts over the last three years have been big ones. This fiscal year, for the first time since 1960, the Department of Defense budget for space is larger than NASA's.

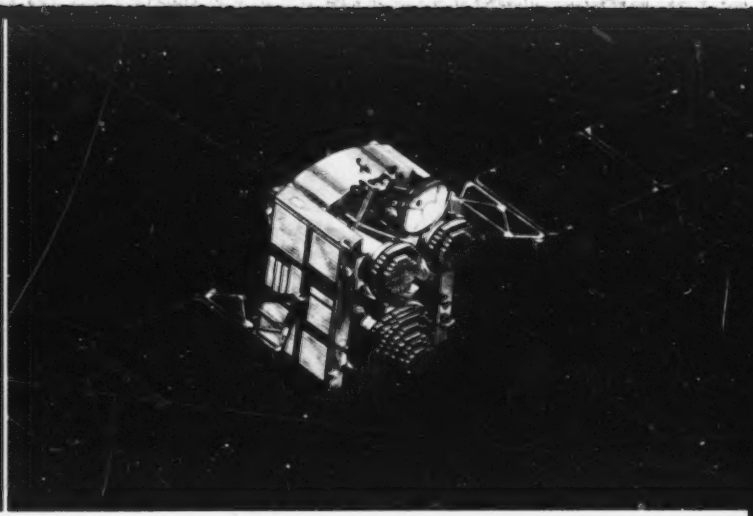
Space has also been upgraded within the DoD organizational structure. For years, the Air Force Systems Command lumped space effort with missile activities, but there is now a separate Air Force Space Division responsible for everything from R&D to command and control of operational satellites. Last fall, the USAF created a new Directorate of Space in the Pentagon; where the Space Division focuses on program management, the Directorate is concerned with broader policy and planning matters, such as the USAF Space Master Plan now being formulated.

Here is a rundown of what DoD is doing in space:

Space Transportation System

As it does in civil use, the Space Shuttle—built primarily by Rockwell International, Martin Marietta Aerospace and Thiokol Corporation—offers a number of special advantages in military operations. Aside from the basic benefits of reduced cost and quick access to space, the big gain is in weightlifting. Ultimately, the Shuttle will be able to orbit double the payload and triple the volume that can be accommodated by the USAF's largest launch vehicle, the Martin Marietta Titan III. This added boostability allows design of larger satellites, important because military spacecraft generally carry more equipment than their civil counterparts—for example, survivability gear, coding systems for message security, anti-jamming equipment or multiple back-up systems





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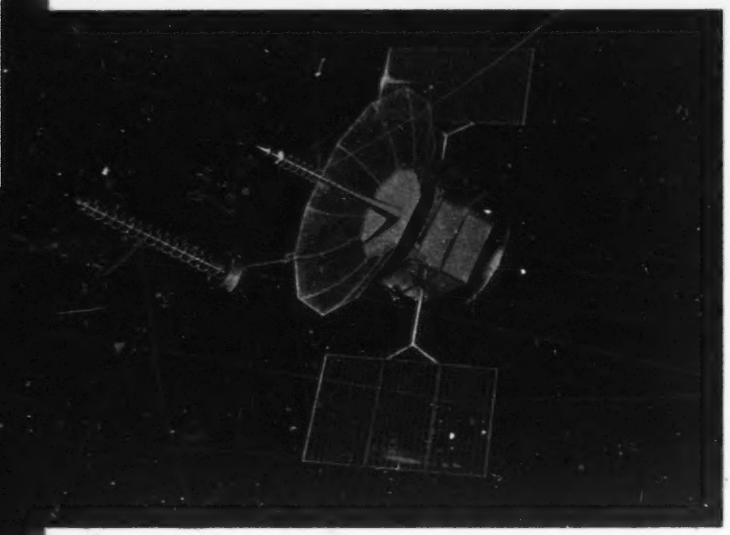

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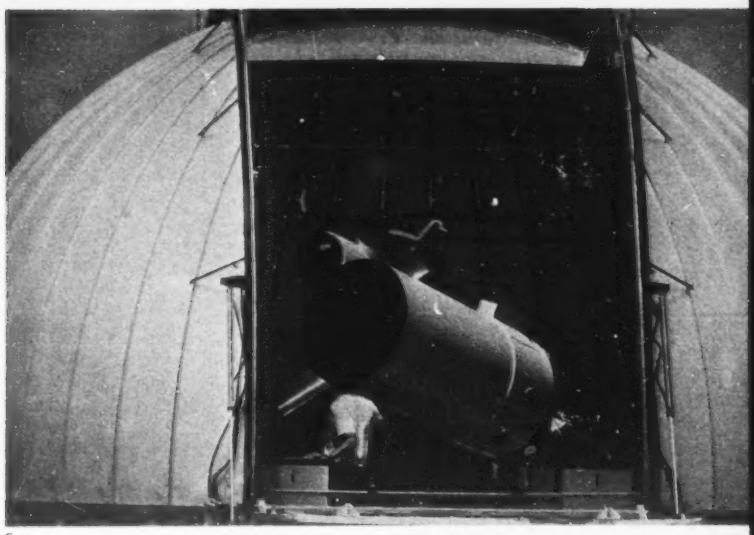

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3. Shown mated to a space probe, the Inertial Upper Stage being developed by the USAF is a "space tug" designed to boost large payloads to altitudes not attainable by the Shuttle Orbiter.

4. The Defense Satellite Communications System (DSCS) provides long range communications for worldwide command/control and other voice/digital message traffic. The current system has four DSCS II satellites (left); the first satellite of a new DSCS III family (right) will be launched this year.

5. The Fleet Satellite Communications network links ships, submarines, aircraft and ground stations.

6. The USAF's Ground-based Electro Optical Space Surveillance (GEODSS) system employs superpowerful telecopes—capable of spotting a soccer-ball-size object at 25,000 miles—to identify and monitor orbiting spacecraft.

to guard against malfunctions, which could be more critical in a military than in a civil satellite. Also important is the Shuttle Orbiter's ability to retrieve satellites in orbit and repair them or update them by substituting more advanced equipment modules. This offers a dual advantage: extended satellite lifetime and better performance through incorporation of the latest technology.

At Vandenberg Air Force Base, California, the USAF is building a Shuttle launch, recovery and refurbishment complex similar to NASA's at Kennedy Space Center (KSC), Florida; Martin Marietta Aerospace is the contractor for design and integration of the ground support equipment and facilities for servicing the Shuttle Orbiter. The West Coast base will allow launch of intelligence-gathering and other satellites into polar orbits; such launches are impracticable from KSC. The Vandenberg facility is designed to support six to 10 flights a year in the mid-1980s and eventually 20 a year. The first Shuttle launch from Vandenberg is planned for October 1985.

In the meantime, DoD will lean on NASA for Shuttle indoctrination, starting with a defense payload aboard the final Shuttle test flight this summer. A number of NASA-operated Shuttle missions from KSC have been set aside for exclusive DoD use; no information has yet been released on the types of payloads, altitudes, durations or other particulars. The first such mission will be the 10th Shuttle flight, scheduled for November 1983; there will be two more in 1984 and five in 1985. Even after the start of Shuttle operations at Vandenberg, the USAF will sometimes launch from KSC, when boosting payloads requiring near-equatorial rather than polar orbits; similarly, NASA satellites will be sent into polar orbits from Vandenberg. In 1986, the Air Force will open a Consolidated Space Operations Center (CSOC); the CSOC will control all military Shuttle and other missions in the manner that Johnson Space Center in Houston handles space command and control for NASA.

The Shuttle Orbiter's top operational altitude is about 600 miles, but many payloads must be sent to higher orbits. Communications satellites, for example, usually operate at 22,300 miles in what is called geosynchronous orbit; at that height, the satellite's movement is syn-

chronized with Earth's rotation so that the satellite remains over a fixed position on Earth. Delivery to high altitude orbits is accomplished by upper stage propulsion units carried in the Orbiter's cargo bay affixed to the payload. The Orbiter releases the combined payload/upper stage at an altitude of about 160 miles, then the upper stage rocket motor is ignited to send the payload to geosynchronous orbit. For boosting big payloads (up to 5,000 pounds), the Air Force is developing the inertial Upper Stage (IUS); Boeing Aerospace Company is prime contractor. The IUS will make its flight debut next January, boosting a NASA communications satellite. For smaller payloads, both NASA and the USAF will use the PAM (Payload Assist Module) upper stage, privately developed by McDonnell Douglas Astronautics Company.

Intelligence Satellites

Intelligence satellites are orbiting observation posts for such purposes as global surveillance, attack warning and communications interception. Intelligence gathering was one of the earliest applications of military spacecraft. In 1960, the Air Force launched the first of a series of MIDAS Lockheed-built (Missile Defense Alarm System) satellites equipped with infrared sensors for "detecting the launch of a ballistic missile seconds after it leaves the launch pad." Also in 1960, the USAF started operating a companion system developed by Lockheed called SAMOS (Satellite and Missile Observation Satellite).

In the early sixties, DoD clamped a security lid on intelligence satellites and since then has said little about them officially, except to acknowledge that reconnaissance and early warning satellites are in operational status. Presumably they are very sophisticated systems, in view of the Air Force's 20 years of developmental experience.

Support Satellites

Communications, obviously, are vitally important at every level of military operations. In operation or soon to be operational are several types of DoD comsats relaying signals in different frequency bands to serve a variety of military communications needs. They include:

- The Defense Satellite Communications System (DSCS), currently comprised of four DSCS II satellites and two spares operating at geosynchronous altitude. Built by TRW Inc., the satellites support worldwide command and control, crisis management, intelligence data relay, early warning and diplomatic message traffic.

Late this year, the USAF will launch the first R&D version of a new satellite, DSCS III, developed by General Elec-

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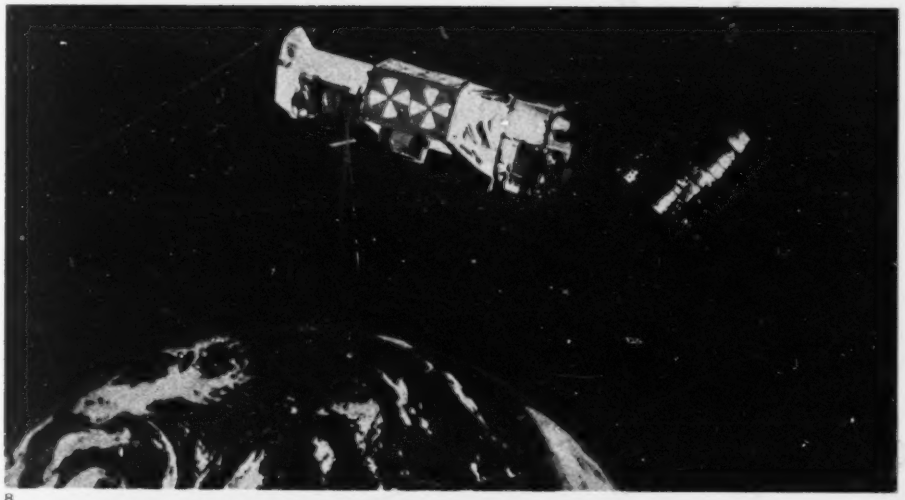

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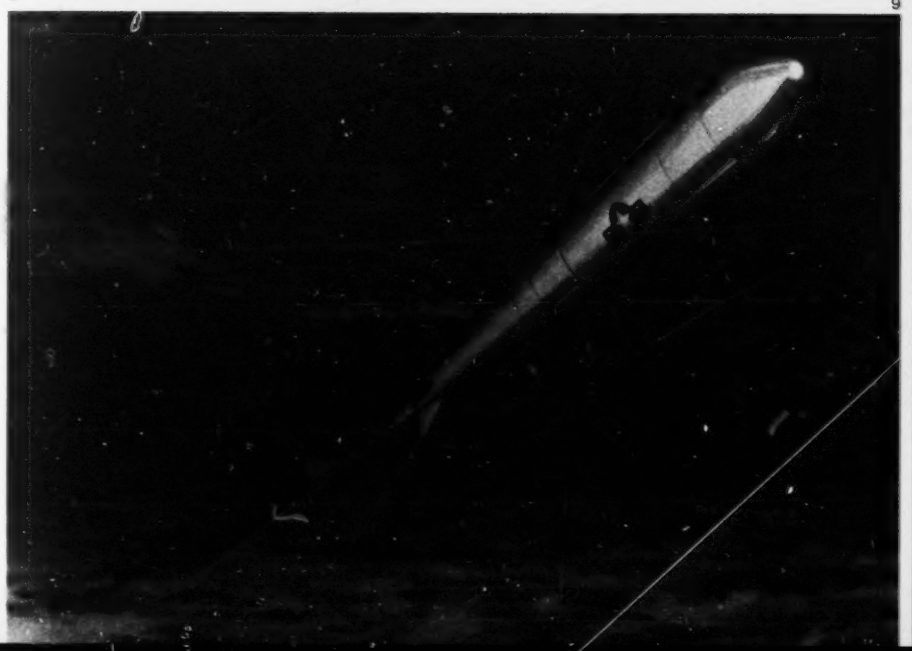
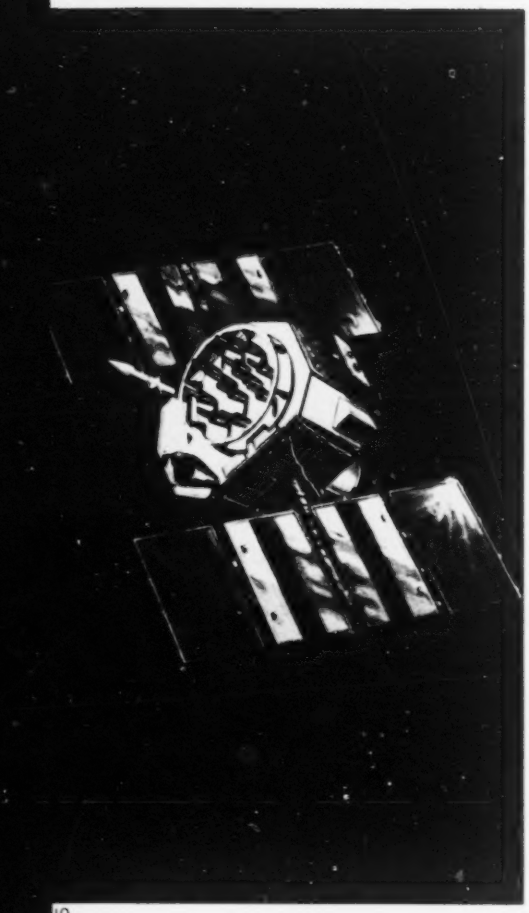


7. Beginning in 1984, the high-capacity Leasat will relay signals to Department of Defense tactical elements.

8. Highly sophisticated spacecraft of the Defense Meteorological Satellite Program send up-to-date weather data directly to military units all over the world.

9. In USAF development is a fighter-launched antisatellite weapon known as the Prototype Miniature Air-Launched Systems.

10. The Navstar Global Positioning System will enable operators of aircraft, ships, submarines and land vehicles to determine their locations within 50 feet. An interim six-spacecraft system is already in orbit; an advanced system of 18 satellites will become operational in the latter 1980s.



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tric Company's Space Division. To be operational in 1985, the DSCS III system offers longer satellite life, greater capacity and improved protection from jamming.

- The Fleet Satellite Communications system (FltSatCom), a five-satellite network for linkage from ship to ship, ship to shore and ship to aircraft. TRW Inc. is prime contractor.
- The Satellite Data System, which provides communications for strategic forces. Contractor is Hughes Aircraft Company.
- The Air Force Satellite Communications System, not a satellite but a communications package, or transponder, carried aboard FltSatCom and Satellite Data System spacecraft. Produced by General Electric, it provides data communications for command and control of nuclear forces.
- Leasat, a high-capacity Hughes-developed satellite, to be leased by DoD for communications service to tactical users beginning in 1984.

A space support system described by DoD as "one of the most critical of wartime readiness elements" is the Defense Meteorological Satellite Program (DMSP), a means of providing military units all over the world the latest weather information, independently of the civil meteorological system operational in the U.S. and among allied nations. In service since 1976 and since upgraded by more advanced satellites, DMSP is a highly-sophisticated weather reporting system that provides photographic and infrared images, along with temperature and moisture level data, and information on the location and intensity of atmospheric disturbances that affect radar signals and communications transmissions. The system consists of two satellites, each of which scans the Earth every 12 hours and reports directly to naval vessels at sea or to tactical vans on land. The satellites are built by RCA Astro-Electronics.

Rounding out the space-based support systems category is the Navstar Global Positioning System (GPS), developed by Rockwell International. Navstar is an artificial star that provides a space reference point for determining the position of a military vehicle with a degree of accuracy never before attainable. Each satellite continually transmits its position to receiving sets on the ground; computer processing of signals from four different satellites enables a military user to fix his position—and altitude—anywhere on Earth within 50 feet. There are now six developmental GPS satellites in orbit; there will be 18 advanced versions when the system becomes fully operational in the latter 1980s. Navstar GPS will substantially improve aircraft operations, particularly precision bombing at night or in bad weather. Receivers are being developed for ship and submarine use, and manpack receivers carried by ground troops will allow more effective artillery targeting.

Ground-based Systems

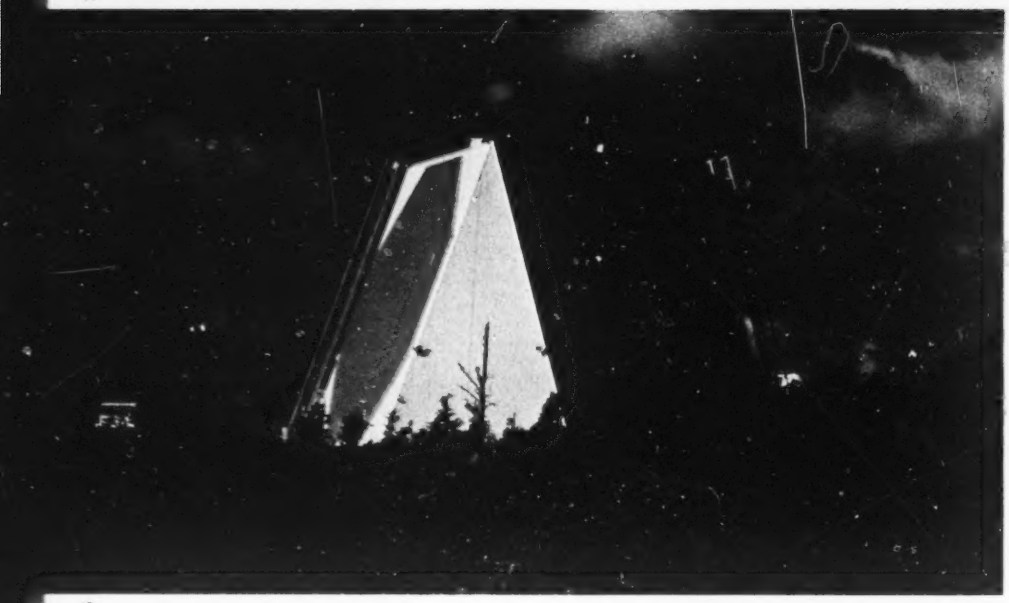
When the Space Shuttle went aloft on its first flight last year, launch vibration dislodged a number of protective tiles on the Shuttle Orbiter. It could have been a serious problem if the Orbiter had lost tiles from its wing or underbelly, where re-entry heat builds up to its greatest intensity. NASA announced that the missing tiles were not located in critical areas, according to an in-flight examination by the Air Force. Just how the Air Force had been able to inspect the relatively small tiles of a spacecraft orbiting more than 100 miles up was, at the time, a mystery.

The USAF has since confirmed the existence of a spacewatch system called GEODSS, for Ground-based Electro-Optical Deep Space Surveillance, which can spot an object the size of a soccer ball at 25,000 miles. Expected to be fully operational in 1983, GEODSS will consist of five installations, equipped with superpowerful optical telescopes, in New Mexico, Hawaii, South Korea and at sites in the Indian Ocean and in the eastern Atlantic. Telescope images are fed into a computerized system that enables identification and constant monitoring of objects in space. TRW is GEODSS prime contractor.

Satellite monitoring is also accomplished by two ground-based systems of highly-advanced radars, both developed and built by Raytheon Company. One, called Cobra Dane, is located on Shemya in the Aleutian Islands; its principal job is tracking Soviet missile development flights. The other, known as Pave Paws, consists of two active installations, one each in California and Massachusetts, and two more to be emplaced in Florida and in the Southwest. In addition to satellite watching, Pave Paws is designed to provide early warning of sea-launched ballistic missile attack. Both Cobra Dane and Pave Paws are "phased-array" radars; instead of the conventional scanning dish, they employ thousands of individual, stationary radar beams coordinated by computers. Since no mechanical parts limit the radar scan, they can detect orbiting and ballistic-trajectory objects more rapidly and they can track hundreds of targets simultaneously.

Antisatellite Weapons

Since the Soviets are known to be developing antisatellite (ASAT) interceptor weapons, it is imperative that DoD develop a similar capability. Last year the USAF contracted with Vought Corporation and Boeing Aerospace Company for two different versions of what



11. Located on Shemya in the Aleutians, the highly advanced Cobra Dane radar tracks Soviet missile tests and provides early warning of sea-launched missile attack.

12. A companion to Cobra Dane is the Pave Paws phased-array radar system, which monitors satellites and warns of sea-launched attack. The radar pictured is located at Otis Air Force Base, Massachusetts; there is another on the West Coast. They can track hundreds of targets simultaneously.

13. One of several configurations under study, this is a NASA Johnson Space Center concept of an early manned space station that could serve both civil and military needs. The station would be expanded by addition of Shuttle-delivered modules.

is known as the Prototype Miniature Air-Launched System (PMALS). Designed for launch from the McDonnell Douglas F-15, PMALS includes a two-stage rocket booster and a small missile equipped with sensors for homing on a hostile satellite. Ground-launched ASAT systems are under study.

Advanced Development

DoD's budget plan contemplates substantially increased outlays in the next two fiscal years for space systems and related ground equipment. Aside from funding for the military Space Shuttle program, the budget proposes—for the combined 1983/84 fiscal years—a space defense allocation of more than $400 million; funding for strategic surveillance and warning systems at $400 million for development and more than $1 billion for procurement; and $990 million for development of space communications systems, plus more than $250 million for procurement.

Major areas of research and development include work to improve the overall performance and capacity of space systems; to explore the utility of advanced space weapons, such as high-energy lasers and particle beams; to increase communications security through better methods of resisting jamming and eavesdropping; and, in particular, to increase the survivability of all spacecraft in a wartime environment. In his report to the Congress, Secretary of Defense Caspar W. Weinberger made these comments about DoD's space development plans:

Space Defense. "We are working on information processing improvements to provide better orbital predictions and to support antisatellite targeting and strike assessment. We are also continuing R&D on long wavelength infrared space-based surveillance technologies, and are assessing the technical feasibility of space-based laser weapons."

Early Warning. "Infrared sensors installed on missile warning satellites would provide initial detection of Soviet ICBM and SLBM launches. Currently, these satellites transmit data to fixed ground-based processing stations. To reduce our dependence on these vulnerable facilities, we will deploy mobile ground terminals to receive, process and disseminate missile warning data from satellites."

Advanced Missile Warning System. "Because we are concerned with the potential vulnerabilities of missile warning systems in a nuclear war, we are funding R&D for an advanced missile warning system designed to operate reliably after an initial Soviet attack."

Nuclear Detection System. "The Integrated Operational Nuclear Detonation Detection Systems (IONDS) consists of improved nuclear detection sensors that will be installed on the satellites of the Navstar Global Positioning System. IONDS will greatly increase our capability for rapid detection, location and reporting of nuclear detonation world-

wide. It will contribute to nuclear test ban monitoring and intelligence collection in peacetime. In a nuclear war, it would provide damage and strike assessment information."

Communications. "To control our forces effectively during a nuclear war, we would need two-way communications with jamming protection between commanders and forces. Therefore, we are funding the development of new satellite communications system (MILSTAR) providing extremely high frequency (EHF) communication channels that would be able to operate against severe enemy jamming."

Space Station

The "Star Wars" aspects of space operations—combat with laser, particle beam or other "death ray" weapons—have caught the public attention and fostered an impression that such weapons are closer to reality than they actually are. One consensus of experts holds that high-energy lasers, shooting intense light beams capable of knocking out a satellite, might be in operational service in 10 years; there are some, however, who feel that effective space weaponry is even further away. But with or without weaponry, there appears to be a very important role for the manned military space stations as a "high ground" platform for human-directed Earth surveillance, command/control functions, and payload deployment, servicing and retrieval.

In 1971, the Soviet Union launched Salyut 1, an interim space station subsequently visited by two teams of cosmonauts in Soyuz spacecraft. For more than 10 years thereafter, the U.S.S.R. maintained an almost continuous presence in orbit with six Salyuts visited by manned crews on 23 occasions, sometimes for as long as 175-185 days. This program has given the Soviets a wealth of experience in space station design and operation. Reports suggest that the U.S.S.R. has already embarked on development of a permanent space station. Leonid Brezhnev more or less confirmed it when he stated in a speech last year that the U.S.S.R. would build a permanent "scientific" orbital structure and "we are now ready to make the next step in this direction."

U.S. space station experiments have been limited to NASA's 1973-74 Skylab program, in which three crews visited a large "orbital workshop" for periods up to 84 days. The U.S. has no space station in active development. Thus it would seem on the surface that the Soviets have a very large lead in this area of space development. Depends on how you look at it.

A manned military space station needs a regular and timely link with Earth. It cannot function in isolation; it must have a means of rotating crews, bringing up payloads or weapons, delivering new instruments and equipment, and resupplying the station with oxygen, food, water and other expendables. It seems unlikely that these functions could be effectively handled by relatively small spacecraft—such as Soyuz—boosted by one-shot launch vehicles. Efficient military operations in space will require a reusable, rapid access, fast turnaround, large payload delivery system to support the space station—in short, a vehicle like the Space Shuttle. The Soviets may be developing such a system, but there is no hard evidence; in any event, it has not yet flown. The U.S. Space Shuttle, on the other hand, will become operational in November and many of the activities planned for it are space station-related.

So, the Soviets elected to develop first the orbital segment of the combined space station/Earth link system, while the U.S. decided to focus on the orbital access vehicle and use it as a base for space station construction. The matter of "who's ahead" will hinge on who develops quickest the other half of the combined system.

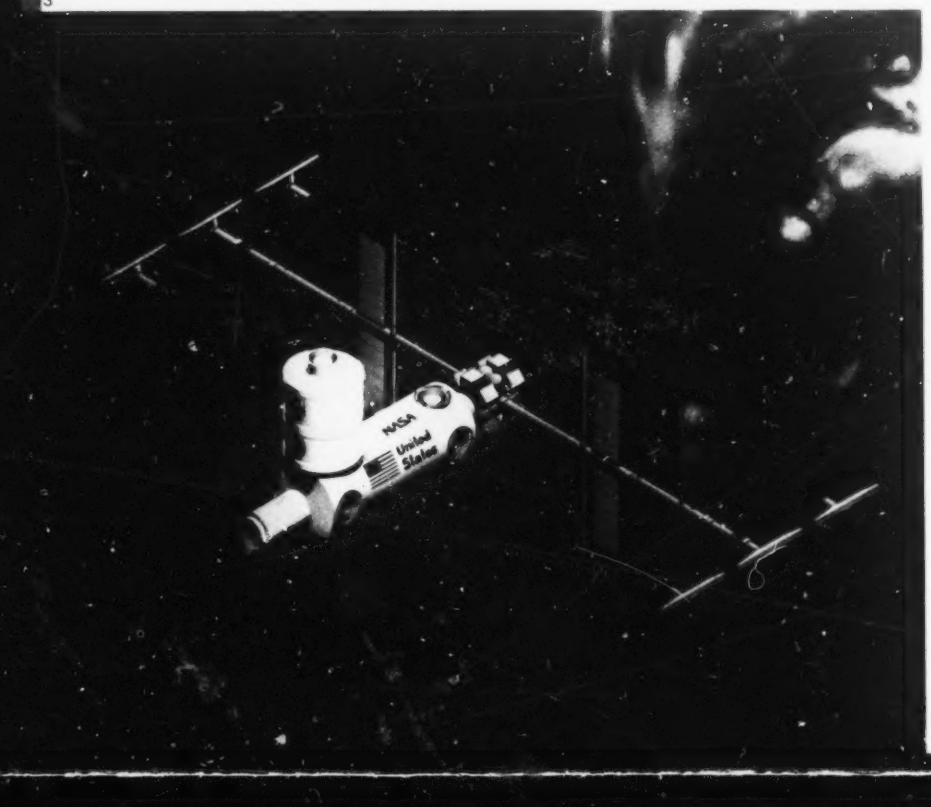
The Department of Defense is actively studying space stations and orbital operations but has said little publicly. The high cost of a permanent, multi-occupant space station suggests that its development will necessarily be—as was the Shuttle—a *national* project aimed toward serving both civil and military needs. Thus, NASA's space station plans provide a clue as to what direction the U.S. might take and in what time frame.

NASA is promoting the space station as "the next logical step" and is conducting studies on various configurations; major contractors involved are Rockwell International, Boeing Aerospace, Grumman Aerospace, McDonnell Douglas and TRW Inc. Where earlier concepts envisioned a need for a new heavy lift vehicle—a Super Shuttle—to build the space station, current studies recognize the realities of funding the project in a tight-money era; to keep costs in the affordable range, they would use the existing Shuttle as a construction base and resupply vehicle.

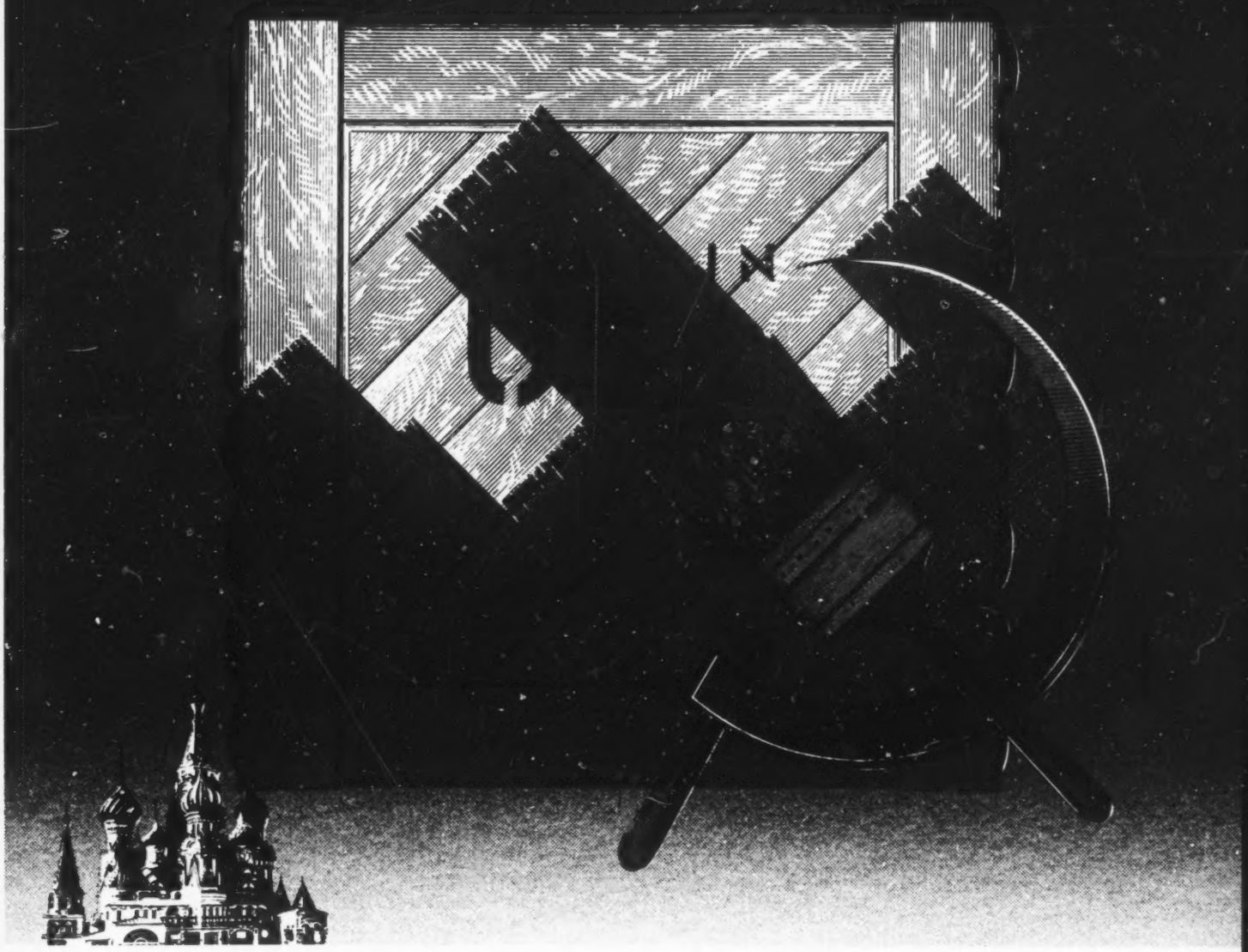
In either of two approaches investigated, the initial facility would be a modest, Shuttle-deployed platform containing solar arrays for electric power, communications and data management systems, provisions for supporting unmanned experiment payloads, and a docking core. Over time, the basic platform would evolve into a large, manned orbital station through Shuttle delivery of fully-equipped modules maneuvered into docking berths—modules for human habitation, experiments, supply storage and whatever special equipment is needed for specific missions.

There is no funding in the current budget, and none proposed in next year's budget, for active development of the space station. But, given approval in Fiscal Year 1984, the basic platform could be in orbit by 1987 and an initial manned facility could be operating by the end of the decade, serving both NASA and DoD. Because the type of orbital path best suited to defense operations is different from that of a civil-use facility, it would probably be necessary—after an experience-gaining period—to erect a separate military station. A two station program would not be cheap, but neither would it be prohibitively expensive if constructed by the evolutionary approach, using current technology in large part and building on the Space Shuttle's capabilities.

3



RAIDING THE FREE WORLD'S



Reprinted from *Defense 82*, a publication of the Department of Defense

TECHNOLOGY

The USSR has taken advantage of our loose export controls and—legally or otherwise—acquired vital goods and equipment.

BY RICHARD N. PERLE
Assistant Secretary of Defense
For International Security Policy

Richard N. Perle is a former staff member of the Senate Permanent Subcommittee on Investigations; Subcommittee on Arms Control, US Senate Committee on Armed Services; and Subcommittee on National Security and International Operations, US Senate. He has also served as a consultant with the Advanced Studies Group, Defense and Space Center, Westinghouse Electric Corporation, and with Sandia Corporation.

The Soviet Union is undertaking a large-scale effort to improve the technological quality of its huge war-fighting apparatus. The assessment of the Department of Defense and of the Reagan Administration is that this highly coordinated Soviet effort is being carried out at the expense of the Free World by a raid on our technology base.

Soviet leaders have learned that they have access to Western technology both through legal and illegal channels. Under the guise of purchases for benign, civilian objectives, the Soviets have obtained a wide range of equipment critical to their military program. Where they have failed to get what they want openly, they have resorted to a well-coordinated, illegal acquisition program. Using agents, co-opting citizens, taking advantage of unsuspecting business men and women, moving goods through neutral and third world countries, exploiting the weaknesses in our control system, they are gaining access to Western technology on an unprecedented scale.

Until now, the West has failed to respond to this challenge. Our export requirements were too loose. Our enforcement program was lax. Too many loopholes in our international control system persisted. Clear-cut violations of international export laws were forgiven and forgotten. Violators, when they were caught, were either not punished or got off with modest fines.

> They are using our free institutions and our open system against us.

The result? The Soviet raid on our technology base not only continued—it increased in scope.

Let me describe for you how all this occurred, how the Soviets profited as a result, and what we are doing about it.

We would do well to recall that only a decade ago it was fashionable to believe the Soviet Union would shift its emphasis from military pursuits to improving the material well-being of its citizens. Many felt the Soviets, with the right encouragement, would manufacture fewer guns and, instead, produce consumer goods greatly desired by their people. Accordingly, national and international controls were restructured to give the Soviet Union more access to Western technology and products.

Sophisticated goods and equipment were sold with winks and nods from Free World countries. Indeed, it is a sad fact the United States actually requested and received more exceptions to the international control list than any other participating Western nation. It is even more grim to note, in retrospect, many of the exceptions granted to the United States under the international control program contributed *directly* to Soviet military modernization.

Today, we can see the result of the laissez-faire attitude of the last decade in the size and in the technological capability of the Soviet armed forces. The Soviets have introduced new generations of smart weapons, dramatically improved their airlift capability, made their nuclear weapons more accurate and deadly, and enhanced their command and control with better computers and communications.

The Soviet Union fields some 50,000 effective main battle tanks and over 20,000 artillery pieces, all of which are protected by a sophisticated anti-aircraft net which can move with the Soviet land army. There are more than 5,000 helicopters supporting the armed forces including helicopter gunships, some of which are in service in Afghanistan. In Eastern Europe alone, there are 3,500 advanced tactical bombers, interceptors and fighter aircraft. In the last eight years, Soviet military industry has turned out over 1,000 fighter aircraft each year. The operational supersonic Backfire bomber can support Soviet land and naval forces in critical areas such as the Middle East and Persian Gulf.

In addition, the Soviets are expanding their nuclear arsenal. Western Europe, Japan, and China are under the shadow of a new family of Soviet SS-20 intermediate range ballistic missiles. Each missile is equipped with three independently targeted nuclear warheads.

Despite the evidence showing that the Soviet Union continued its military build-up and modernization program, the liberalized system of international export controls was allowed to persist unchanged. As a result, the Soviets continued to use Western technology to sup-

port their burgeoning military-industrial system.

Today, there are over 135 military industrial plants operating in the Soviet Union, spanning over 40 million square meters of factory floor space and turning out more than 150 major weapons systems. In addition, there are hundreds of factories producing both civilian and military goods, with the first priority always for the military. And, there is a stand-by system of dedicated factory space to pick up military production in wartime.

Since 1970, despite "detente," the USSR has increased its military manufacturing base by 40 percent. In the comparable period, our military industry shrank as our defense investment declined. While we struggled over what weapon systems to produce, and cancelled many important programs, the Soviets pushed ahead dramatically.

Nor did their effort stop with adding manufacturing capacity. The USSR has been enlarging its research and development structure to support its growing military industry. In aerospace alone, in this past decade, they have expanded their research and development capacity by over 30 percent.

The manpower pool of scientists and engineers for research and development is also expanding. In 1980, this base of professionals consisted of 900,000 engineers and scientists—the world's largest. It is sobering that, for 1980, the Soviet Union graduated an additional 300,000 engineers to buttress this undertaking.

Even with massive domestic effort and the help from the Warsaw Pact countries, such as East Germany and Czechoslovakia, the Soviets cannot, nor are they trying to, go it alone. They rely heavily on Western technology for industrial modernization and new products.

From the Soviet point of view, there are immense benefits from exploiting the West's advanced technology base.

The Soviets want their computers to work with future generations of Western equipment.

These benefits to the Soviets include:

- Saving billions of dollars by acquiring proven Western technology,
- Saving years of research time,
- Avoiding mistakes and errors that are costly and time-consuming,
- Knowing in advance that new systems will work properly and, alternatively, knowing where to look should a particular project get in trouble.

The list of technology for military use acquired from the West is a long one. It includes high-speed computers used for designing weapon systems, signal processing, command and control and intelligence gathering; semi-conductor manufacturing know-how used to make Soviet weapons more reliable and precise; guidance technology for aircraft, ships, submarines, and missiles; and equipment to improve the Soviet military industrial base—ranging from precision machine tools to process know-how technology.

Much of this has happened because our international control system has broken down. That control system is centered around a voluntary organization called the "coordinating committee," or COCOM. Under COCOM controls, critical goods were legally exported to the Soviet Union. Some examples include:

- Western shipbuilding know-how and equipment including dry docks, expanding their naval construction and repair capabilities.
- Heavy vehicle construction plants and plant support facilities, giving the Soviets a quantum jump in load durability and reliability and far better mobilization potential. For example, Kama River trucks are used by the Soviet army in Afghanistan.
- Western semiconductor and microelectronics know-how, giving the Warsaw Pact an electronics manufacturing system that is operating in support of the military. In addition, modern printed circuit facilities were exported to the Soviet Union.

These legal acquisitions are supported by even more far-reaching illegal acquisitions. For example, only this past summer, millions of dollars worth of high grade electronic polysilicon were diverted to the Soviet Union to fill military needs.

Illegal acquisitions are taking place across a wide front. To give just one example, the Soviet Union illegally acquired IBM 360 and 370 main frame computers from the West. Their objective was to use the IBM computer as the base design of their own *Ryad* computer series. The copy was nearly exact,

and for a very good reason. They wanted their computers to work with future generations of Western equipment. It is interesting to note the Soviet Ryad computer series uses the same repair manuals as the IBM.

There are many ways the Soviets acquire embargoed equipment. One is to have the goods sent to a neutral or non-aligned nation and then divert it to the Soviet Union. Neutral countries generally do not maintain embargo laws. Some very sophisticated electronic gear and manufacturing equipment have been transferred this way.

The Soviets support the illegal acquisition drive through controlled "front" corporations, by co-opting business men and women and factory workers, through bribery and shady deals.

They also maintain an intelligence system keyed strongly on emerging technologies of high military value. They keep a close watch on the latest developments in the computer industry, in advanced large-scale integrated circuit design and manufacturing know-how, on magnetic bubble memory technology, on developments in genetic engineering, fracture mechanics, and superplasticity.

One part of this collecting system is devoted to exploiting Western technical literature, including technical information published by our own government.

The President Imposes Sanctions

Following the repression in Poland—for which the Soviet Union bears a heavy and direct responsibility—the President announced a number of sanctions against the Soviet Union. Several of the measures bear directly on the issues discussed by Assistant Secretary Perle in the accompanying article.

- The Soviet Purchasing Commission has been closed.
- The issuance or renewal of licenses for the export to the USSR of electronic equipment, computers, and other high-technology materials has been suspended.
- Licenses will be required for export to the Soviet Union for an expanded list of oil and gas equipment. Issuance of such licenses have been suspended. Pipelayers are included.
- US-Soviet exchange agreements coming up for renewal in the near future—including the agreements on energy and science and technology—will not be renewed. There will be a complete review of all other US-Soviet exchange agreements.

Even before the crackdown on human rights in Poland, though, the Reagan Administration had been moving on a broad front to protect Western technology from Soviet acquisition efforts. The United States seeks to prevent manufacturing know-how from reaching the Soviet Union where it can be used to support their military industrial base. The focus is on controlling critical production equipment and production technology.

Eastern Europe. Although there is a political-economic basis for differentiating between Warsaw Pact members, DoD sees little basis, if any, for differentiating between the military production contributions made to the Warsaw Pact forces by its East European members. Of considerable further concern is the likelihood of the Soviet Union acquiring advanced Western technology from any Warsaw Pact member by exerting the necessary pressure or sometimes merely requesting the information or product. There is evidence that the Soviets have sought to have at least one Eastern European country favored by the West act as a conduit for Western technology not otherwise available to them. There is reason to believe this one source is not alone. Therefore, the Defense Department is exercising considerable care as part of its participation in the review process and in asserting as clearly as possible the national security concerns connected with proposed exports.

COCOM. "Surely the time has come to make COCOM more effective and to restore the confidence and trust that must be felt by all who participate," Mr. Perle told Congress last fall. "We look to COCOM to tighten up the international control structure and take a more active enforcement role through member nations. We also hope to see a major list review in 1982 to assure that the whole COCOM system is overhauled."

Critical Technologies. The Military Critical Technologies List (MCTL) effort is headed in the Department of Defense by the Office of the Under Secretary of Defense for Research & Engineering. The list underwent a major revision in FY 1981, with industry participating in the effort, and the revised document was completed on October 1, 1981.

Until now, there have been no changes in the Commodity Control List (CCL) directly based on the MCTL effort. However, a number of recent COCOM proposals have been developed based on information garnered from the MCTL undertaking.

"At some point soon, we will be reviewing the revised MCTL and comparing it on a point-by-point basis with the CCL," Mr. Perle said. "We hope, thereby, to make recommendations for revisions of the CCL to take advantage of the considerable research effort represented in the MCTL effort."

ICEBERGS FROM AN ECONOMIC GLACIER

By H. C. MUNSON
Vice President—Strategic Planning
Boeing Commercial Airplane Company

I liken our airlines to a fleet of ships sailing in a business sea filled with deregulatory icebergs. These icebergs were formed when the government began to thaw the economic glacier of government regulation. The airlines—or ships—are being *forced* to chart new courses in an effort to avoid the visible and hidden dangers. As a major supplier of these airlines, Boeing finds itself in the same predicament.

There is no doubt that some of the fleet will be lost. One well known North Atlantic operator—Laker—has already disappeared. Are we all destined to go the way of the Titanic?

I think not. The air carrier industry's chances for survival are 100 percent.

Why? Because society today is highly dependent on travel. And air transportation is by far the most convenient and economical means of travel over distances of any consequence. The underlying fundamentals which drive air travel are *right*.

The demographics are right. The portion of the population who are most likely to travel—those between the ages of 25 and 45—is the fastest growing segment of our population.

The propensity to travel is right. Some may find it surprising that the money spent on air travel has been increasing during a period in which traffic is declining. However, the money spent on air transportation is up and was up more than the gross national product in both 1980 and 1981.

The maturity of the system—and lack thereof—looks right. Historically, each primary mode of travel has experienced accelerated growth, then maturity and finally decline with respect to the Gross National Product. Where does air transportation stand today? It depends upon the location. It is clearly in a relatively mature state in the U.S., over the North Atlantic, and approaching, if not mature, in intra-European operations. It is clearly in the high growth cycle in the Far East and Mid-East and it is entering the high growth cycle in South America and Africa. It is in its infancy in societies such as India and the Republic of China.

The absence of a strong competitive alternative looks right. There is no technology on the horizon destined to replace air travel. Telecommunications has arrived and the future outlook for growth is very promising. But just as the use of the telegraph and telephone produced synergistic growth in air travel, so—the experts tell me—will telecommunications produce similar growth and air travel stimulation will exceed diversion.

When we integrate the preceding considerations, we conclude that we have far more growth in air transportation ahead of us than we have behind us.

People are sometimes confused by the difference between the rate of growth, and absolute growth. Boeing forecasts a declining *rate* of growth in air travel. But, on average, the actual increase in passengers boarded and revenues generated will be greater each year of the next decade than in any previous time period. As a result of this outlook for traffic, we forecast that airline needs for new airplanes over the next ten years will be in excess of 100 billion constant 1982 dollars.

The immediate outlook for the airline business is lousy. The balance sheets of the airlines have been battered by a combination of a run-up in expenses, soft traffic, resultant excess capacity and inadequate fares.

The pressures on airline costs appear to be easing—fuel prices have stabilized and some workers are taking pay cuts and reducing their demands in recognition of the precarious financial state of their companies. An excess of capacity has allowed some of the economically obsolete equipment to be grounded, without creating an immediate requirement for new replacement equipment. This latter aspect is, of course, good news for airlines in a high interest rate, capital-scarce environment, but it brings little joy to Boeing.

When Senator Cannon recently asked the Air Transport Association if Congress should consider re-regulating the airlines, the answer was categorically "No." I agree with ATA's response. I do not agree with the airlines when they omit deregulation from the current list of problems affecting their balance sheets. Excess capacity and unprecedented competition have caused non-compensatory fares to become the rule instead of the exception of many major routes.

We have had three-plus years of deregulation and in that time period we have had two recessions. We have proved, I think conclusively, that deregulation hurts when times are bad. But we have not yet examined the benefits of airline deregulation during an economic upswing. If the airlines can convert unprecedented losses during a recession into unprecedented earnings during good times, we may yet be able to live with this brave experiment called deregulation. One could list dozens of benefits from deregulation, many of them already confirmed in practice, but profits are missing. However—we still have to test deregulation during periods of prosperity. The key is what happens during periods in which there is little or no excess capacity in the system.

If the airlines continue to compete on a below cost basis—there will be no profits to generate to retained earnings required for future investment. It is for this reason that I find the current safe harbor leasing provisions in the 1981 Tax Recovery Act to be of critical importance. I suggest that the airlines can return to profitability, but it will take considerable time for the air carrier ships to learn to sail successfully between the deregulatory icebergs. The safe harbor leasing provisions represent an opportunity to reinforce the capital structured hulls of the airline ships at sea so that a single modest navigational error will not sink the vessel.

Economic cycles have always aggravated the planning process in our commercial airplane industry in other ways as well. For example, you can only launch a new airplane program on an economic up-cycle in which the airlines have the capital required to commit to the new program. All too often, it seems, the next major economic decline is at its low just about the time a company is getting ready to deliver the new airplane launched during the prior period of prosperity. This was painfully true for the 747 and is again the case as we approach the end of the development period on Boeing's new fuel-efficient 757 and 767 transports.

One last point: A brief comment about the Export-Import Bank. We have a foreign competitor—Airbus Industries—who would like nothing better than to displace the United States as leader in the commercial airplane field. They want the business that this country now enjoys and the balance of trade benefits and the jobs that go with it. If Airbus achieves its objectives, at least a quarter of a million current U.S. high technology jobs will be transferred from the United States to the European Economic Community.

We have no complaints regarding vigorous competition. We have never been in better shape to take on competition. We welcome the challenge; some of us may even relish it. But the single most influential force which would ultimately cause us to change our planned course is the disparity in the financing available for U.S. versus European products. The Administration now supports a budget and a policy which severely restrict the only source of funding to which our customer airlines have access for parity in financial terms and conditions. Just as safe harbor leasing is the mechanism which can strengthen the airlines, the aggressive use of Eximbank funds is the mechanism which will strengthen the U.S. commercial airplane industry in a competitive environment during the economic cycles which are inherent in our system.

Our government needs to adopt trade policies which recognize that most other nations prefer controlled markets to free markets, and that only by strongly representing U.S. trade interests will controlled marketing be constrained.

While both the U.S. commercial aircraft manufacturing sector and the U.S. air carrier industry are among the strongest in the world, there is no doubt that the next year or even the next few months are critical to both of us. We are adrift at a time when world conditions affecting our industry, including economic and political facts, are far beyond our individual resources or even our collective capabilities.

I know of no one seeking a government bail-out, but we are all seeking goverment policies and programs which will allow us the opportunity to meet our responsibilities aggressively in a turbulent and iceberg-laden sea.

Notable views of notable people on aerospace matters...

aerospace perspectives

Alexander M. Haig, Jr., *Secretary of State, addressing Georgetown's University's Center of Strategic and International Studies, Washington, D.C.:*

"A concept which has recently attracted interest is that of a freeze on nuclear weapons. While being sensitive to the concerns underlying this proposal, we have had to underscore the flaws in such an approach. A freeze at current levels would perpetuate an unstable and unequal military balance. It would reward a decade of unilateral Soviet buildup and penalize the United States for a decade of unilateral restraint. . . . Such a freeze would remove all Soviet incentive to engage in meaningful arms control designed to cut armaments and reduce the risk of war. . . .

"If nuclear weapons offer the only deterrent to nuclear blackmail, some would argue we should submit rather than pose the risk of nuclear conflict. This choice, however, is a false one. By maintaining the military balance and sustaining deterrence, we protect the essential values of Western civilization—democratic government, personal liberty and religious freedom—and preserve the peace. In failing to maintain deterrence, we would risk our freedoms while actually increasing the likelihood of also suffering nuclear devastation. . . . We must reject this false alternative. . . . In the nuclear age, the only choice consistent with survival and civilization is deterrence."

Congressman Newt Gingrich, Georgia, *in a statement to the Subcommittee on Space Science and Applications, House Committee on Science and Technology:*

"I believe that the issue of space is one of vital importance to the future of our nation. It is quite clear to me that we must invest in that future. . . .

"The economies of Japan and Germany bear witness to sound, long-term financial planning on the part of their governments. . . . We, on the other hand, have consistently walked away from the opportunities we could have developed. Years ago, we were at the point where we could have dominated space for defense. We could have led the world in scientific achievement where space and space-related technologies are concerned. . . . We could have retained the cutting edge in technology. Unfortunately, years ago we did not have the foresight to accept that challenge. . . .

"Technically, it is quite clear that NASA could and should spend $9 billion in Fiscal Year 1983. . . . Any NASA budget less than $9 billion . . . means that 10 years from now we'll have another million Americans who won't be working because we didn't have the courage to venture forth into the frontier that lies before us."

Casper W. Weinberger, *Secretary of Defense, in his annual report to Congress:*

"Fears that the defense budget of this Administration will strain the American economy are unfounded. In the 1950s and 1960s, when defense spending as a percentage of the Gross National Product was much larger than today, annual inflation rates ranged from about one to seven percent. Economic studies have found little difference in the effect of defense and non-defense spending on inflation.

"Defense spending, like other federal spending, produces something which contributes to the people's welfare. The very purpose of our economy is to meet the needs of our people. Defense is an urgent need, and we have ample resources to meet it. As British Air Marshal Sir John Slessor put it: 'It is customary in democratic countries to deplore expenditure on armaments as conflicting with the requirements of social service. There is a tendency to forget that the most important social service a government can do for its people is to keep them alive and free!'"

Ronald D. Neal, Sr., *Vice President—Program Management and Technology, Gates Learjet Corporation, testifying before the Subcommittee on Science, Technology and Space, Senate Committee on Commerce, Science and Transportation:*

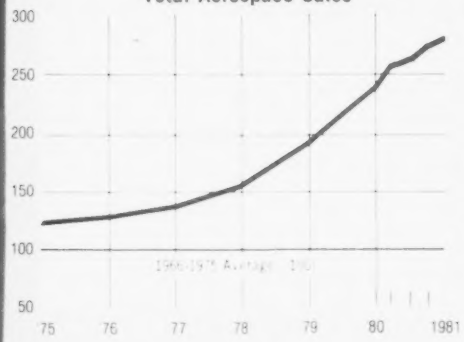
"The design of the first Learjet, certificated in 1964, drew heavily from an immense data bank provided by NACA/NASA researchers, whose work was accomplished as much as 25 years earlier. Over the years, we have made increasing use of more recent NASA research. Now, our company has caught up with NASA. Today we are working cooperatively with NASA at the razor edge of the technologies we need. The historic path of basic research findings. . . . has been shortened by many years. We are now at the point where we work with NASA on a day-to-day basis in certain specialized areas.

"What this means is that airplane manufacturers of our size, whose potential for basic and applied research, though improved, is still limited, will find their progress paced by the progress of NASA. Our future success in world markets. . . . will quite literally and directly depend upon the success of NASA in performing the basic advanced aeronautical research which the agency and the industry can and should do together. . . . The real question before us today is simply this: Whose airplanes will be in our future—those designed and built in the United States, or those produced somewhere outside America's borders?"

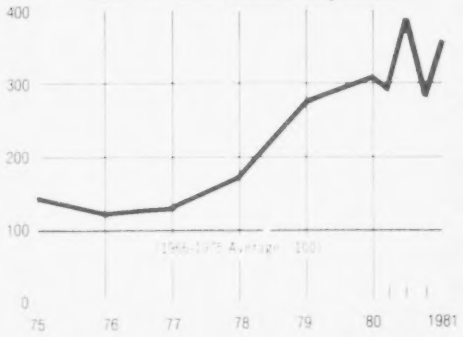
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

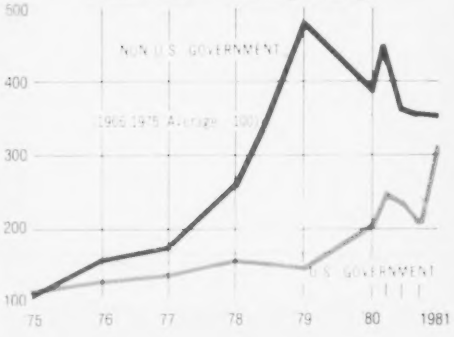


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 4th QTR. 1981
AEROSPACE SALES: TOTAL	Billion $	Annually	24.2	57.6	66.9	68.6
	Billion $	Quarterly	6.1	16.4	16.6	18.4
AEROSPACE SALES: TOTAL	*Billion $*	*Annually*	*25.6*	*31.4*	*35.3*	*35.4*
(In Constant Dollars, 1372=100)	*Billion $*	*Quarterly*	*6.4*	*8.9*	*8.5*	*9.2*
AEROSPACE PRIME CONTRACT AWARDS: TOTAL	Billion $	Quarterly	5.8	17.6	16.5	20.1
U.S. Government	Billion $	Quarterly	4.1	9.7	8.6	12.5
Other Customers	Billion $	Quarterly	1.7	7.9	7.9	7.6
BACKLOG (Major Aerospace Mfgrs): TOTAL	Billion $	Quarterly	28.6	90.5	96.4	98.7
U.S. Government	Billion $	Quarterly	15.9	37.2	42.3	45.8
Nongovernment	Billion $	Quarterly	12.7	53.3	54.1	52.9
DEPARTMENT OF DEFENSE						
Aerospace Obligations: TOTAL	Million $	Quarterly	2,712	4,663	6,379	6,244
Aircraft Procurement	Million $	Quarterly	1,986	3,182	5,272	4,915
Missiles Procurement	Million $	Quarterly	726	1,481	1,107	1,329
Aerospace Outlays: TOTAL	Million $	Quarterly	2,405	4,007	4,263	5,006
Aircraft Procurement	Million $	Quarterly	1,741	3,241	3,335	3,940
Missiles Procurement	Million $	Quarterly	664	766	928	1,066
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million $	Quarterly	780	1,261	1,141	1,148
Expenditures	Million $	Quarterly	789	1,118	868	1,422
EXPORTS						
Total (Including Military)	Million $	Quarterly	1,038	4,578	4,050	4,344
New Commercial Transports	Million $	Quarterly	345	2,096	1,519	1,680
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	1,218	1,209	1,203
Aircraft	Thousands	End of Quarter	650	668	655	648
Missiles & Space	Thousands	End of Quarter	114	118	122	123
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	9.92	10.46	10.91
PROFITS						
Aerospace — Based on Sales	Percent	Quarterly	2.7	4.0	4.0	3.0
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	4.7	4.7	4.3

* 1966-1975 average is computed by dividing total year data by 4 to yield quarterly averages.
† Preceding period refers to quarter preceding latest period shown.

Source: Aerospace Industries Association

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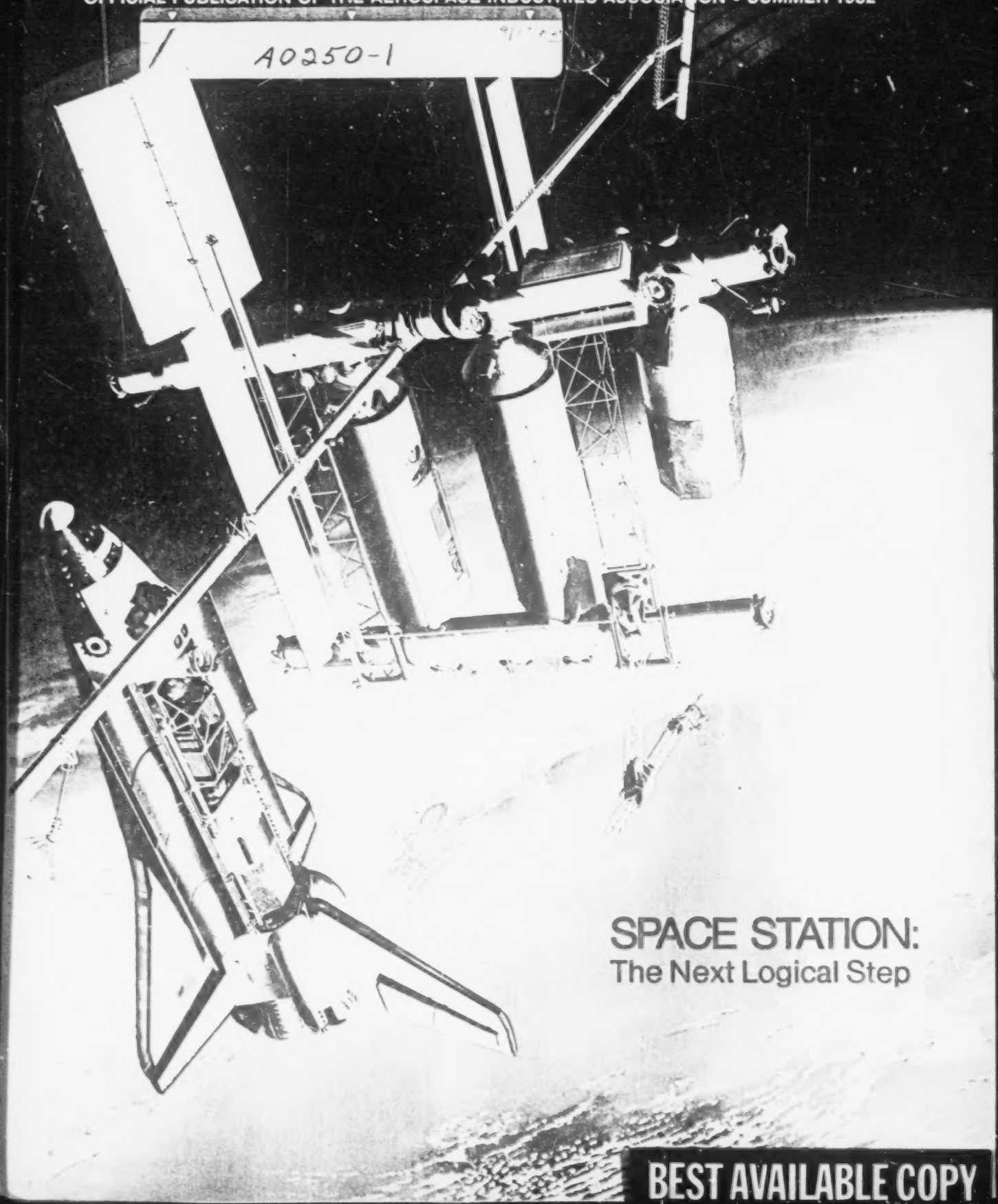

SPACE STATION:
The Next Logical Step

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Notable views of notable people on aerospace matters...

aerospace perspectives

Frank C. Carlucci, *Deputy Secretary of Defense, speaking to the Council of the Americas in Washington, D.C.:*
"Besides using Cuba as a surrogate, the Soviets have increasingly become directly involved in Latin American and Caribbean affairs . . Why the dramatic upsurge of Soviet interest in this region? Primarily because the Soviets recognize that Latin America—especially the Caribbean Basin—is the strategic underbelly of the United States and the Achilles heel of NATO.

"In peacetime, 44 percent of all foreign tonnage and 45 percent of all crude oil shipped to the United States passes through the Caribbean. Two-thirds of Western Europe's petroleum supplies transits the South Atlantic. In war, half of NATO's supplies and most of the U.S. reinforcements and petroleum for our forces in Europe would embark from Gulf ports and sail through the Florida Straits. The region also is the strategic linchpin between our vital interests in the Atlantic and the Pacific; in shifting forces and supplies between those two oceans, the Panama Canal saves a 7,400 nautical mile trip around Cape Horn.

"The Soviets recognize, then, that there are strong linkages between a secure Caribbean Basin and our success in implementing our global security policy. If Soviet expansionism in the Caribbean Basin continues unchecked, every traditional U.S. vital interest—national survival, territorial integrity, economic well-being and world stability—will be jeopardized to an extent unprecedented in our nation's history."

Congressman Robert K. Dornan, *27th District, California, writing in Officer Review:*
"I feel the debate over military preparedness goes far beyond the success or failure of the defense budget. I sense there is starting up again a general trend to attack our military as an institution, and I believe this must be brought out in the open before it gains momentum.

"Presitige media view the military as a ripe target and this perception must be changed. This is a period in which we must give those who serve in our military utmost support. As one member of Congress who has made it my duty to attend as many military top secret briefings as possible, I am stunned by the magnitude of the Soviet military buildup, which can only be described as 'awesome.'

"Every time I see the satellite pictures . . . of the growth of Soviet power . . . I think of these new-budget-cutters meat-axing our U.S. defense capabilities. Once the federal bureaucracy creates a new entitlement program, it seems to be set in stone. With our military, things are vastly different; there is always one more small program that can be axed."

Thomas G. Pownall, *president and chief executive officer, Martin Marietta Corporation, in an address at Salem College, West Virginia:*
"I believe it is beyond argument that in Projects Mercury, Gemini and Apollo we were given dramatically uplifting and inspiration courterpoints to the cares and problems and complications of everyday living, of our Earthly society. I was reminded again of this aspect of space exploration on Independence Day, when nearly a half-million proud Americans seized upon the moment to gather in the California desert, to watch in person the triumphant return from space of the Shuttle vehicle *Columbia* . . .

"It is not too much, I think to place high value on the sense of national self-esteem and prestige that flowed from that event, and from other events in the sparkling sequence of accomplishments in Earth orbital and planetary ventures that we have undertaken since the enactment by Congress in 1958 of the National Space Act and the creation of the National Aeronautics and Space Administration . . . I feel this is a tremendously valuable collateral benefit . . . because I think that whatever encourages us to have national pride and self-esteem is important in this complicated world. If we have no respect for ourselves, we surely will have none for our nation—and we will neither earn nor merit the respect or admiration of other peoples or other nations."

Ruben F. Mettler, *chairman and chief executive officer, TRW Inc., at the annual meeting of the Japan Society in New York City:*
"We are beginning to understand some very basic things, for example: that national economies are part of something bigger—a world economy; that a sound and growing world economy is vital to each nation's ability to meet its own domestic political and social goals; that peace and political stability, and a sound and growing world economy are indivisible—we can't have one without the other; that a healthy world economy, which depends on expanding trade, won't just happen. We have to make it happen, by an unceasing effort to cooperate, to resolve our differences constructively and in a spirit of fairness, and to reduce trade barriers, even when it hurts . . .

"That means that each nation's domestic economic policies and actions are not just their own business—they are the world's business. It also means that if we want to *get* something—such as peace, stability and prosperity in the world—we've got to *give*, or *give up* something, such as behaving as if our own narrow interests are all that really matters."

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Jean Ross Howard

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Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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Minding Our P and Q

By KARL G. HARR, JR.
President, Aerospace Industries Association

In the aerospace industry, Productivity and Quality are spelled with capital letters these days. The industry is making an intensified effort to get more output for less input in its manufacturing operations while simultaneously improving the quality of its products. Greater productivity and better quality are no longer just desirable objectives; they are national imperatives.

Improved productivity and quality are essential countermeasures to the massive Soviet military force expansion. In this military competition, the Soviets have a big advantage. Their leaders don't ask for citizen opinion on how much money should be allocated to the military; they provide what they think is needed. In the U.S., defense must compete for government funding with many other valid priorities. In terms of Gross National Product, the Soviet Union is devoting resources to military programs on a scale roughly double our own allocations. Since we cannot match the USSR dollar for ruble, we must expand the purchasing power of the defense dollar through new efficiencies in every stage of the defense production process and we must effect improvements in quality to increase the capabilities of our defense equipment inventory.

In commercial aircraft sales, our foreign competitors also have an advantage: a variety of supportive measures provided by their governments enable them to offer customers deals that U.S. industry cannot match. We must, therefore, offer a better product at a competitive price, and our ability to do so depends to a considerable degree on improved productivity and quality in the manufacturing operation.

The dual military/commercial challenge from abroad has lent a new urgency and inspired a new dedication to productivity improvement that goes well beyond our previous efforts. This new thrust is gaining momentum. In military production, industry is getting strong support from the Department of Defense, which is conducting cost-sharing manufacturing technology programs, developing new incentives for industrial modernization, and seeking to remove some of the productivity "detractors" inherent in the defense acquisition process—policies and procedures that tend to increase costs of defense hardware, restrain contractors' cash flow and impede industry's accumulation of capital needed for investment in productivity.

We are definitely making progress, but the necessary improvement in productivity won't happen overnight. It will require increased long-term investment, a sharp upsurge in research, much employee retraining and motivation, and a stronger effort by prime contractors to inspire renewed dedication to quality and productivity on the part of their subcontractors. Above all, it will require much more effective government/industry teamwork. Restoring our essential productivity growth will be a tough job, but it must be done—not only by the aerospace industry but by all American industry—if we are to maintain a strong defense capability and effect a lasting economic recovery.

SPACE STATION: The Next Logical Step

BY JAMES J. HAGGERTY

"Space," says NASA Administrator James M. Beggs, "is not just a place to visit; it is a place to work."

The kind of work he has in mind is use of human-directed space systems to accomplish a broad range of Earth benefits—advancing scientific knowledge, developing new technology, improving national security and performing more effectively a variety of Earth jobs. The Space Shuttle, which will begin operational service in November, represents a big leap forward in U.S. capability for doing useful work. Now, space enthusiasts feel, it is time to move ahead on an even more comprehensive orbital workplace, the permanent manned space station that Beggs terms "a logical step in mankind's evolution into a spacefaring civilization."

NASA has been studying space station feasibility for more than a decade and has reached the point where the next steps are settling on a final design and starting hardware development. The agency hopes to get Administration approval and first-year funding in the Fiscal Year 1984 budget now in preparation; if so, the station could be in orbit by 1990.

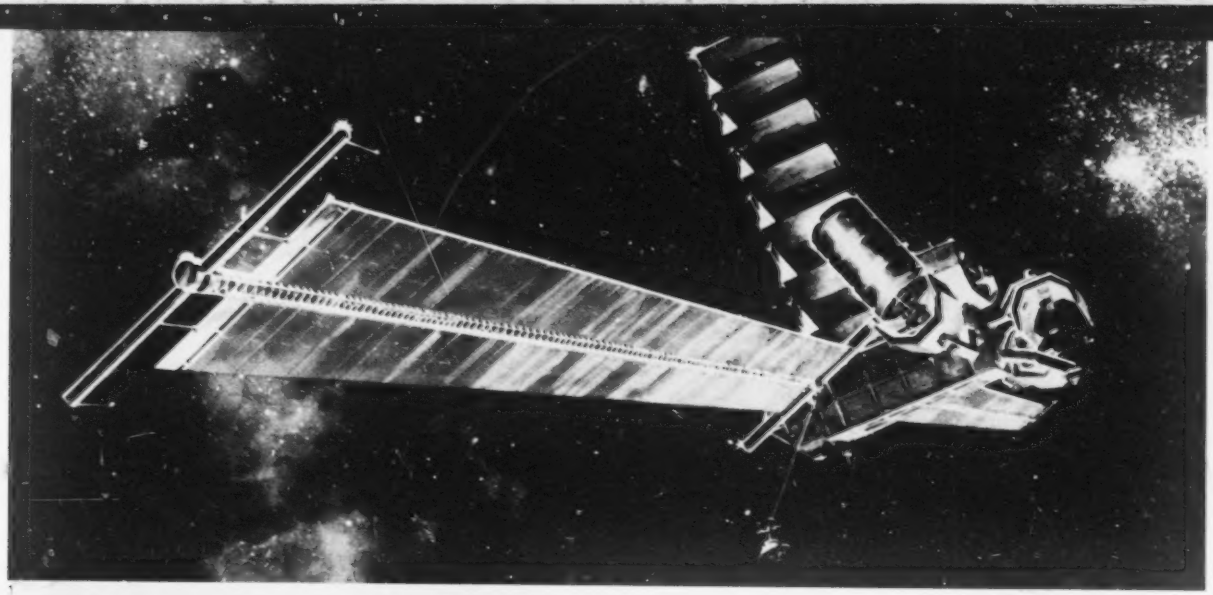
The initial U.S. permanent space station may be a dissappointment to those expecting something like the TV version. It will be a modest facility, manned by a crew of two to four, perhaps even unmanned at first. The reason is that, to keep the project affordable and ease technological demands, NASA has adopted the modular design approach, in which the initial system will be a relatively simple "core unit," expandable over time by the addition of Shuttle-delivered modules.

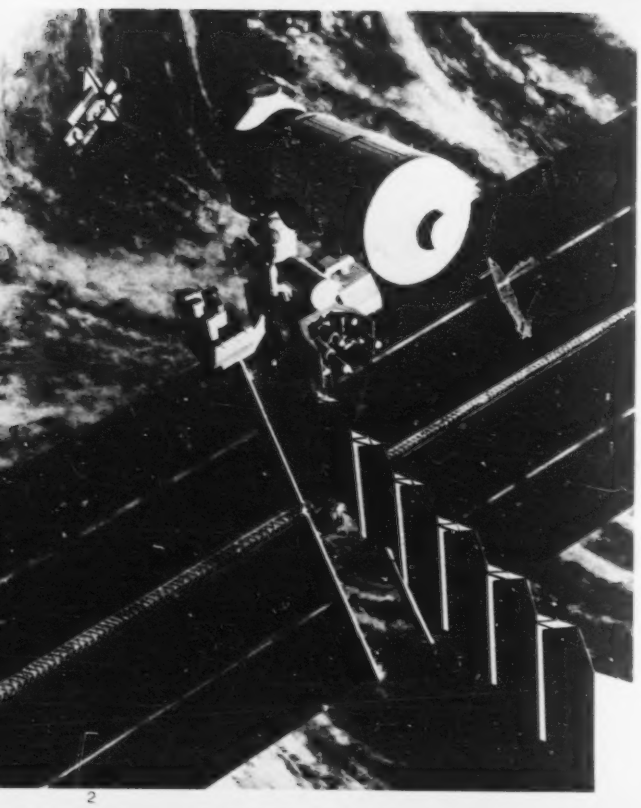
The space station represents a major technological challenge, but there are no major barriers to its development; it is not an Apollo-like quantum jump that forces technological advance, nor will it be anywhere near as costly as was Apollo. NASA's design philosophy is to make maximum use of technology earlier developed in such programs as Apollo, the 1973-74 Skylab temporary space station, the Space Shuttle and the manned version of Spacelab. The latter, a pressurized cylinder that fits in the Shuttle Orbiter's cargo bay, provides keystone technology for the various types of modules that will make up the space station, while the Shuttle itself will be the station's link to Earth.

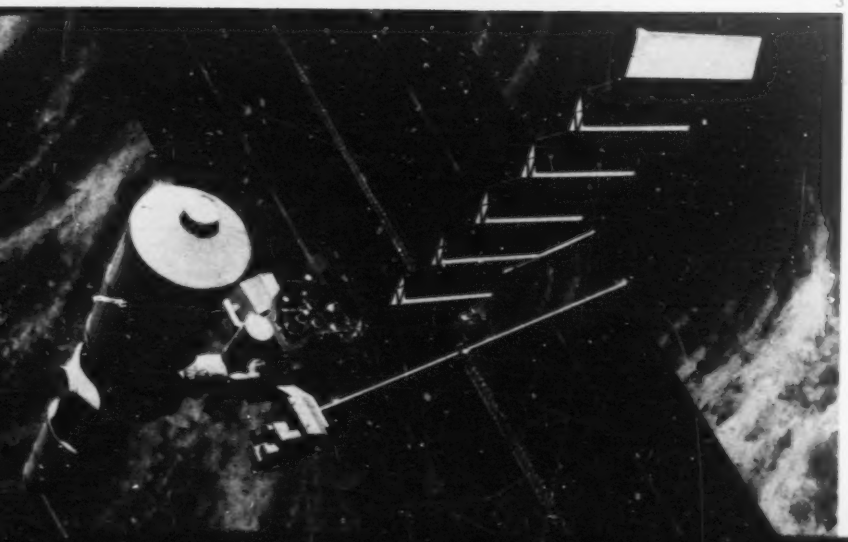
In time, a permanent manned presence in orbit may lead to tremendous Earth advances as man learns more and more how to move about, build in and utilize the space ocean, in the manner that his ability to sail on the high seas produced enormous change and benefit. For the nearer term, the space station offers a number of advantages in the flexibility and effectiveness of space operations:

- It allows continuous operations, where the Shuttle is now limited to seven days, later to 30.
- It affords a significant expansion of the amount of useful work that can be accomplished in space.
- It provides a stable platform for scientific work and permits advantageous human operation of experiments now conducted on an unmanned basis.
- Similarly, it enhances Earth resources observations by allowing human direction of now-unmanned remote sensing systems.
- It serves as a way station between Earth and space; like the base camp for a mountain climb, it is a departure point for missions to the planets, asteroids and comets.
- In the not-distant day when unmanned spacecraft become too large for Shuttle deployment, they can be delivered piecemeal to the station and there assembled, checked out and placed in orbit.
- The station provides a base for Orbital Transfer Vehicles (initially unmanned,later manned), space tugs that can deliver, service and retrieve orbiting payloads.
- It serves as a staging point for comtemplated space-erection of very large structures.
- It can house a laboratory for long-duration materials processing experiments and, later, a factory for space manufacturing.
- It can include facilities where the Department of Defense can gain experience and conduct advanced investigations of the military utility of a manned orbiting platform.

A departure point for the final design effort has been provided by a series of studies conducted for NASA over the past two years by Boeing Aerospace Company, Grumman Aerospace Corporation, McDonnell Douglas Astronautics Company, Rockwell International and TRW Inc. On the following pages are some design concepts that emerged from those studies; they provide some clues as to what the space station might look like and what types of operations might be conducted there.



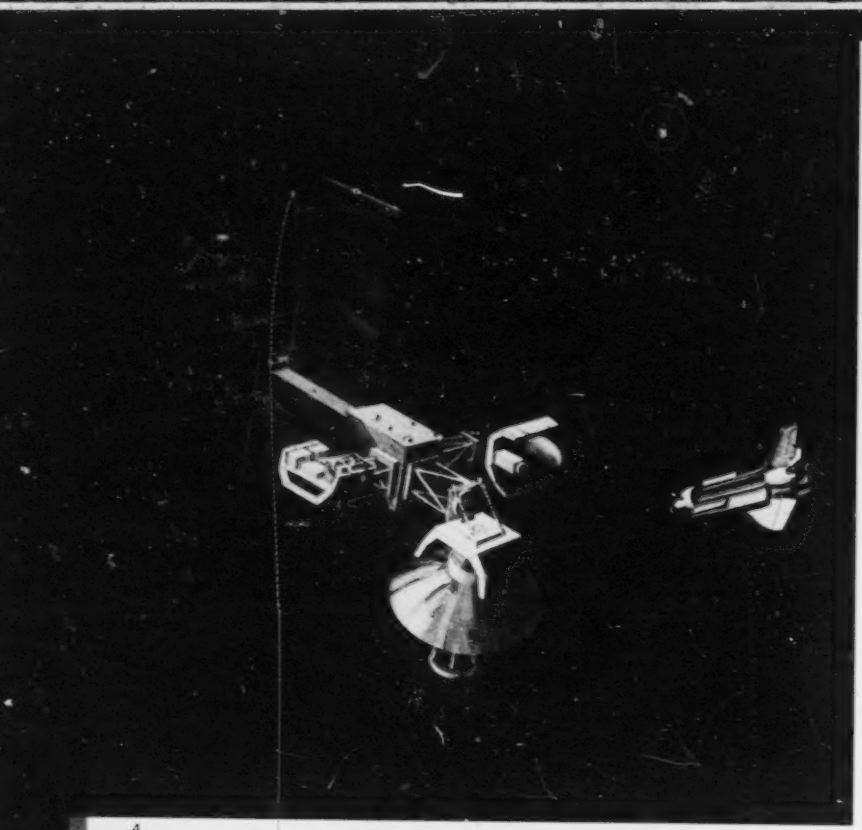




1. These illustrations, based on a study by TRW Inc. for Marshall Space Flight Center, show the first steps in NASA's evolutionary approach wherein the permanent space station will begin life as a relatively simple system and expand by addition of Shuttle-delivered modules. The artwork shows Step One, a basic platform with three pallets for unmanned payloads, carried aloft in compact packages and unfolded in orbit to this configuration. A key element is the long solar cell wing, which converts sunlight to 12/5 kilowatts of electrical power. This basic platform could be in orbit before the end of the decade.

2. In Step Two, the platform becomes a manned space station by the addition of an airlock (bottom center) and a fully-equipped habitable module. At lower right, the Shuttle Orbiter is en route to the station carrying in its cargo bay an additional large module to expand the station further; the module will be extracted by the Orbiter's manipulating arm and nudged to a docking in the airlock's berthing port.

3. The station now has two habitable modules for the crew's living and working quarters. Extravehicular astronauts have added more panels to the solar wing, doubling its power output to 25 kilowatts. The three rotating pallets accommodate a number of unmanned payloads and the habitable modules contain instruments for manned experiments. The oblong main body in the center has equipment for such functions as power distribution, communications, data management, thermal control and "re-boost," or stabilizing the station's orbit. The staircase-like appendage extending from the core is a radiator for getting rid of excess heat generated by the station's equipment.



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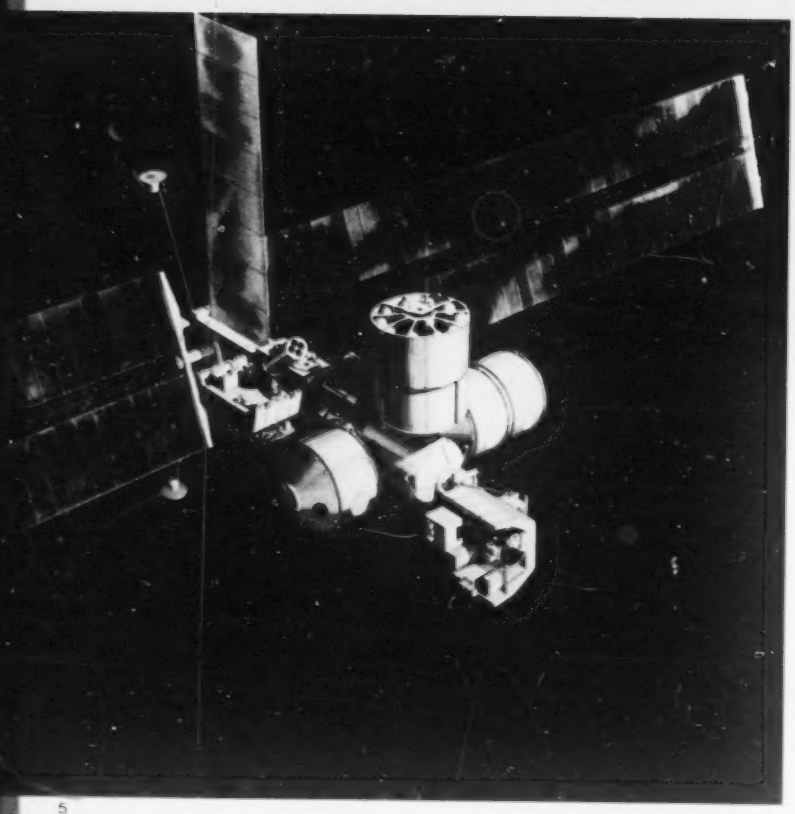

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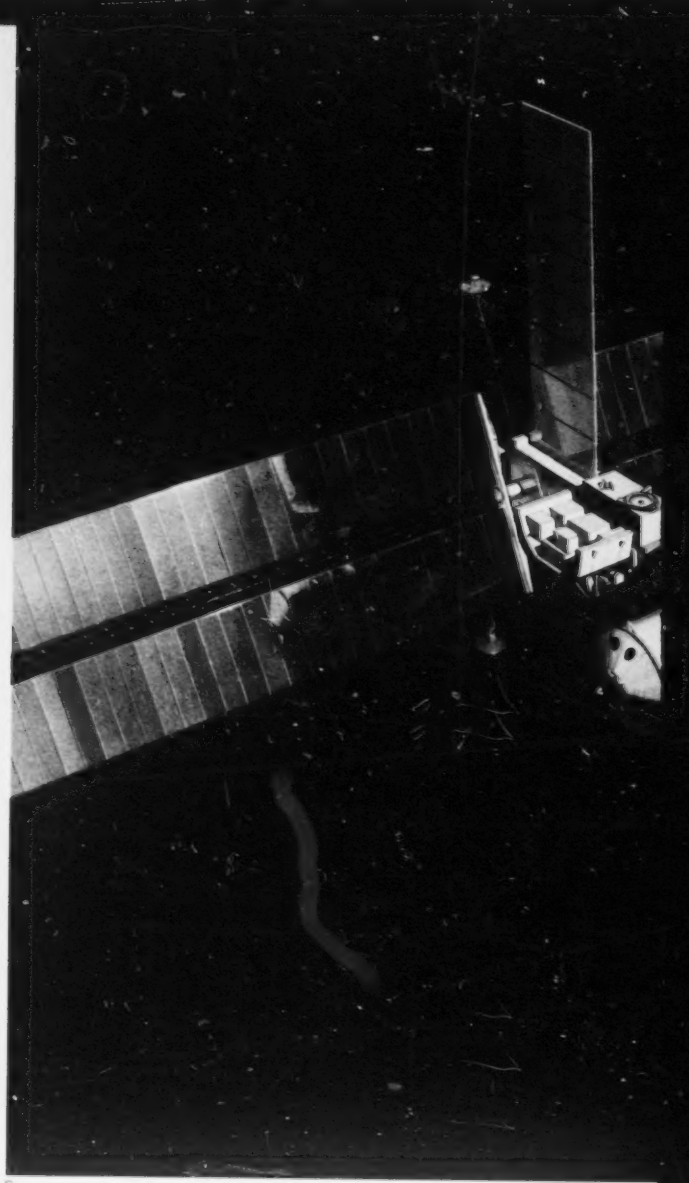

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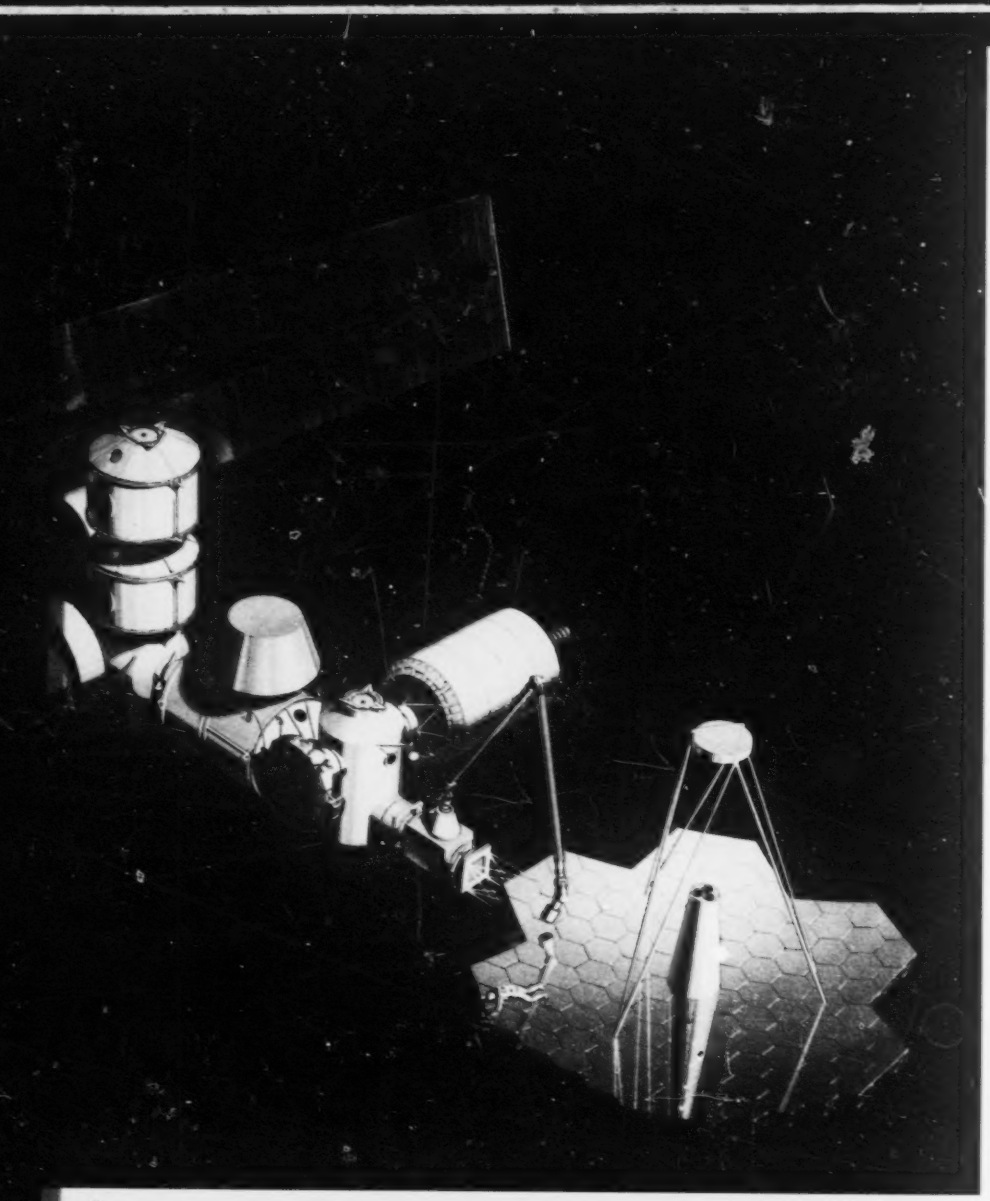

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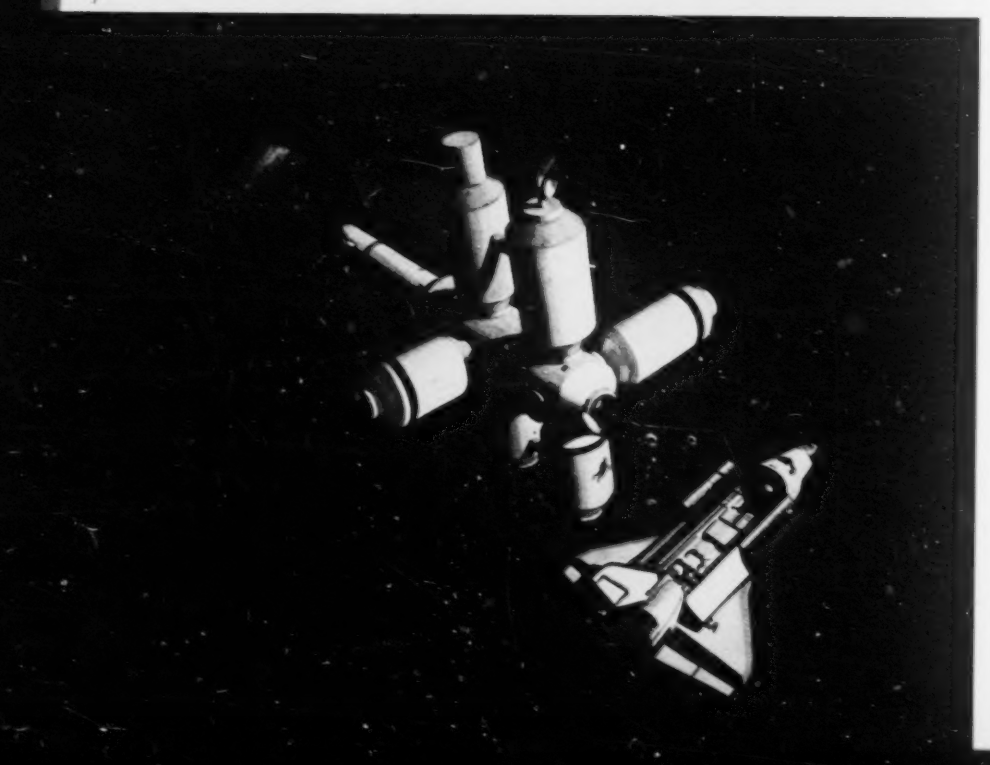
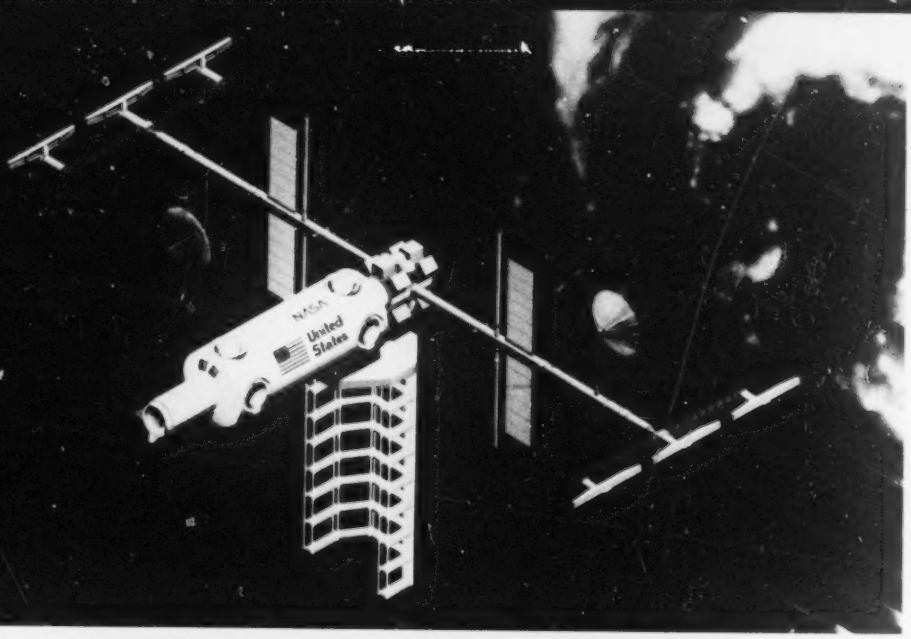


4. This is a basic unmanned space platform envisioned in a study by McDonnell Douglas Astronautics under contract with Marshall Space Flight Center. Its solar wing can be sized to provide 12 to 25 kilowatts of electrical power. The rectangular main body has a space radiator, internal equipment for power distribution and other "core services," and connections for three pallets housing unmanned payloads; the pallets can be rotated to point the payloads toward Earth, the Sun or deep space depending on experiment requirements. Target date for the platform is 1989.

5. About a year after initial deployment, the space platform could become a manned station by the addition of an airlock adapter, a central unit to which other pressurized components would be attached. In this artist's concept, two habitat modules are docked in ports to the left and right of the airlock; each module has living and working quarters for three astronauts. Atop the airlock is a logistics module containing supplies for a long stay in orbit.

6. The McDonnell Douglas station expands to this configuration in a series of module additions, including more habitats and a second airlock. At right center (with red nozzle) is an unmanned reusable Orbital Transfer Vehicle (OTV) used to boost payloads from the station's low Earth orbit to higher altitudes. Next to the OTV is an external "workbench" equipped with a manipulator arm; here astronauts assemble and check out large payloads—such as the large multimirror telescope at right—before transferring them to their design orbits.

7. A Rockwell International concept shows one way of transferring passengers from an Orbiter to the open airlock of a multimodule space factory—by means of pressurized transfer balls (shown in yellow) guided into the airlock by the Orbiter's manipulator arm. The space factory idea is one of the main reasons for development of a space station. It offers exceptional promise for Earth benefit because in airless, weightless space it is possible to manufacture important products that cannot be produced in the presence or Earth's gravity and atmosphere.



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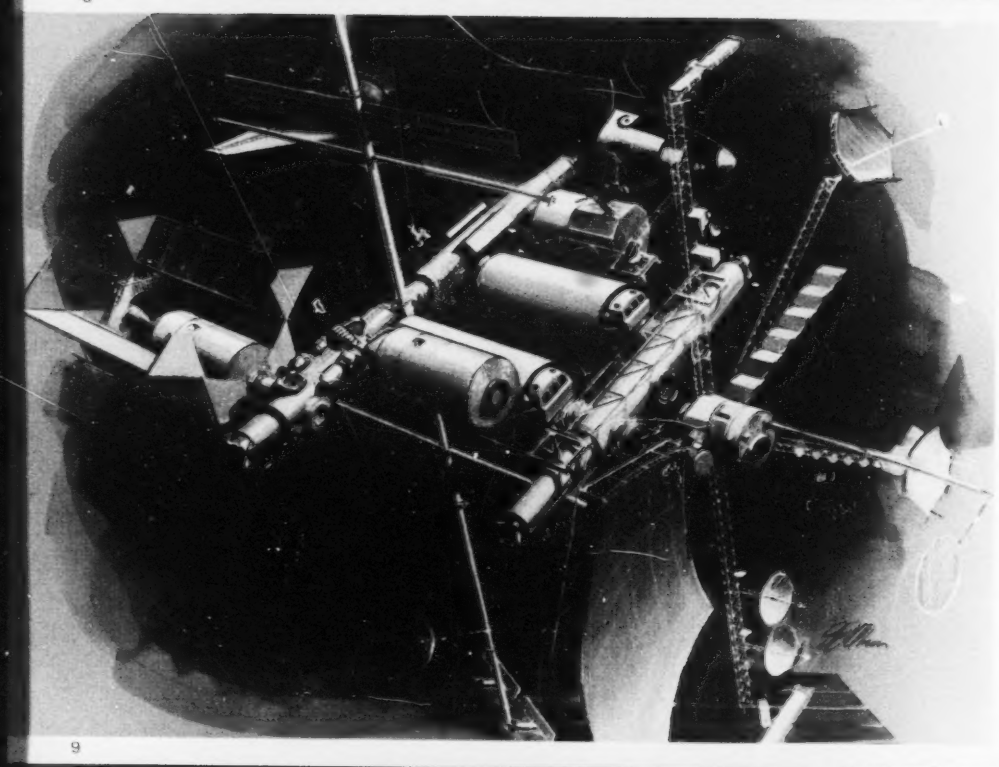

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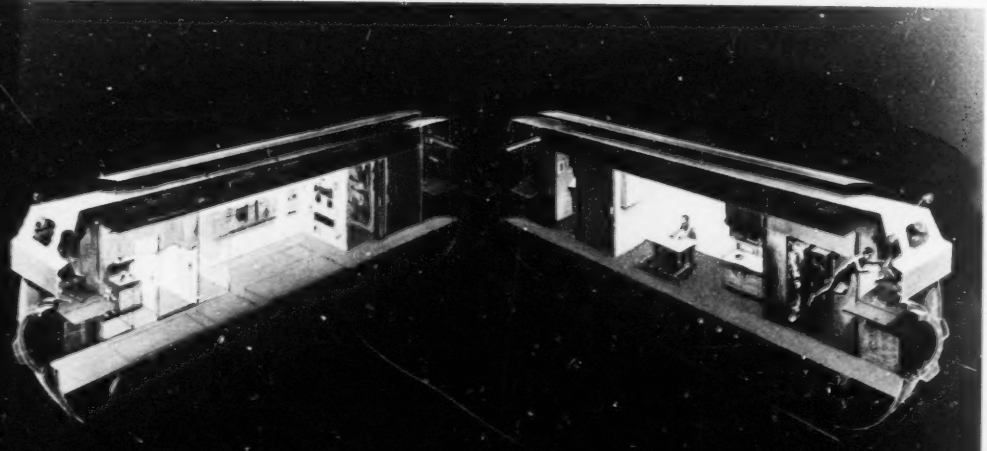

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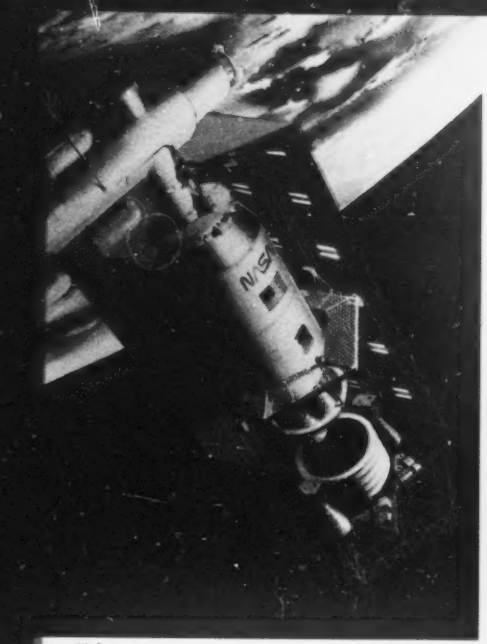
8. Boeing Aerospace Company and Grumman Aerospace Corporation teamed on a space station study for Johnson Space Center. This illustration shows an early stage of an evolutionary Space Operations Center that could be operational about 1990. The initial deployment would include the solar arrays, antennas, radiators and the docking core shown in the center; a later Shuttle mission would add the habitat module. Below the habitat is the framework of a hangar for an Orbital Transfer Vehicle.

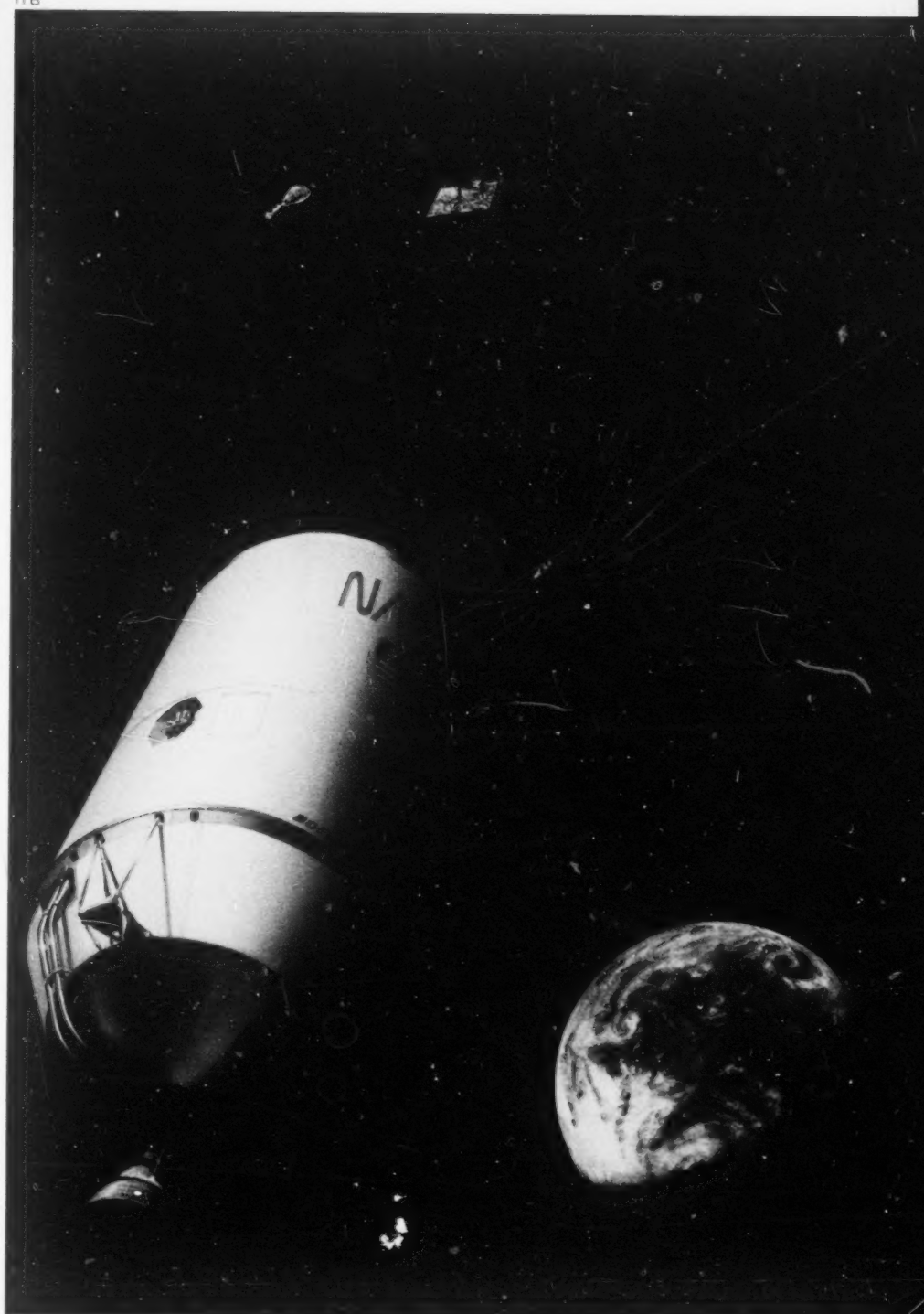
9. This is a Boeing concept of a Space Operations Center manned by a crew of eight, who live and work in the two habitat modules shown in the center of the artwork. The operations center has its own crane for handling new modules or for assembly of spacecraft. In this version, the Shuttle Orbiter is docked at a berthing port that permits direct access to the station through an airlock. The tubular section can be extended in either direction with provisions for docking additional modules or spacecraft. There are service modules containing propellant, batteries, power processing equipment, oxygen and nitrogen supplies; there is also a logistics module (near the Orbiter) that serves as a storeroom for food, water and other expendables. At lower right, a multi-antenna platform is being assembled; it will be placed in orbit by the Orbital Transfer Vehicle shown in the open-door hangar at left.

10. This split view shows Boeing's concept of a habitat module for a crew of four. About the size of a large mobile home, the module would be fully equipped on Earth and Shuttle-delivered to orbit ready for occupancy. Clockwise, the segment shows the command and control center; lavatory and shower; dressing room; exercise/recreation area; two private bedrooms that double as offices; and an observation deck, complete with cameras, telescopes and other instruments. The right segment shows the other half of the observation deck; the third and fourth sleeping rooms; a dining area; the galley; a storage room for extravehicular space suits; and the other half of the command/control center.



11 A

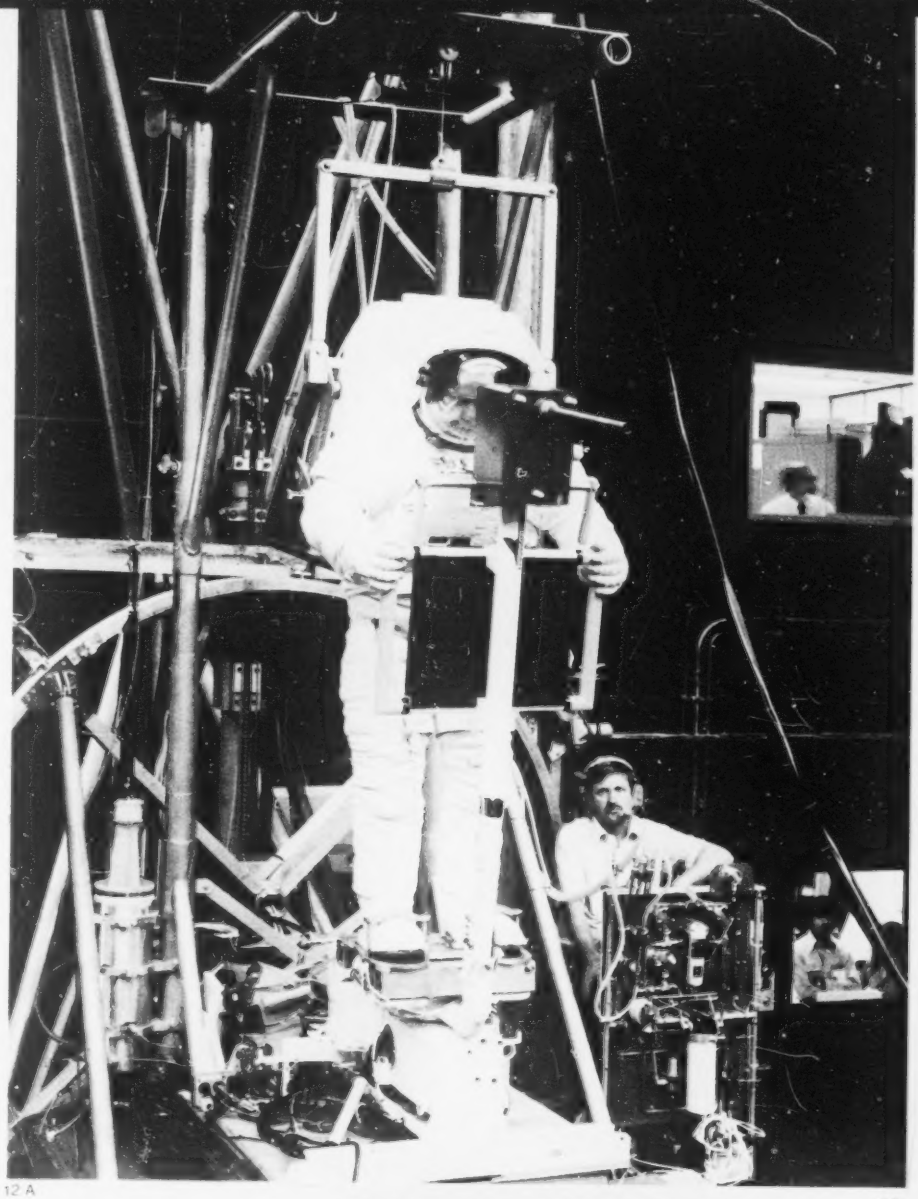
11 B



11. For compatibility with the Space Shuttle, the manned space station will operate below 500 miles, a region termed LEO, for Low Earth Orbit. But many spacecraft operate at the Geosynchronous Earth Orbit (GEO) of 22,300 miles, and others must be launched into interplanetary flight paths. The job of boosting spacecraft from LEO to GEO or deep space trajectory falls to the reusable Orbital Transfer Vehicle (OTV), a space tug permanently based in orbit; Boeing's version is shown in its hangar in Photo A. In the other illustration, the OTV has just positioned a large antenna platform in GEO; it will return to its hanger to await another assignment. Use of the OTV allows great flexibility and cost reduction in orbiting payloads. The Shuttle Orbiter can deliver a number of payloads to the station at one time; there would be extra room in the cargo bay because it would no longer have to haul the upper stage now needed for sending payloads into high altitude orbits. At the station, the payloads would be assembled and checked out, then positioned by OTVs. The initial OTV will be an unmanned system controlled from the space station; later versions will be manned.

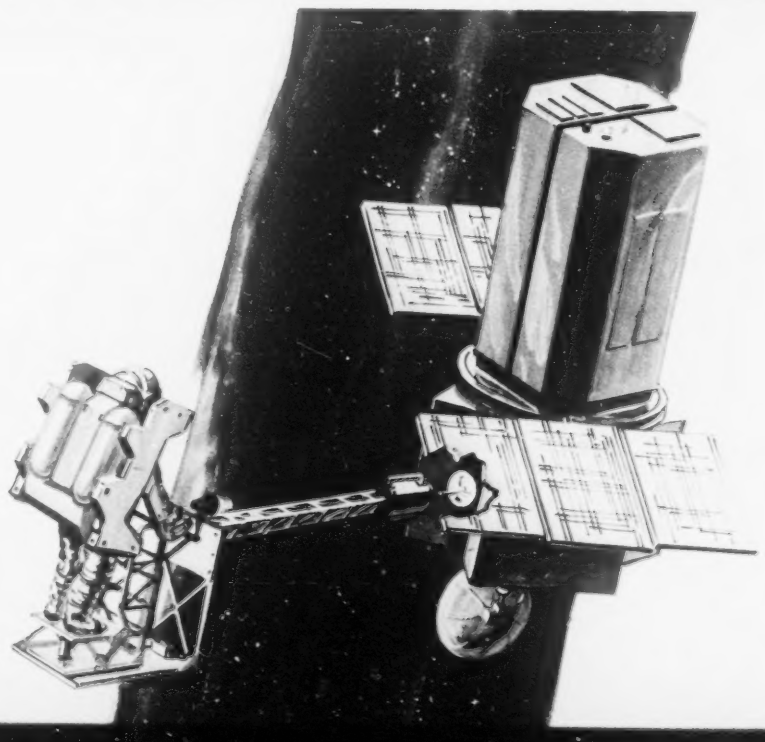
12. In the space station era, there will be need for a number of ancillary space systems, such as the "open cherry picker" pictured at right; already in development, the unit is shown undergoing simulator testing. Grumman Aerospace Corporation borrowed this idea from the truck-mounted movable work stations used by power companies to work on overhead lines. The Grumman unit, formally known as the Manned Remote Work Station, attaches to the end of a mechanical manipulator arm on the space station. The unaided robot arm can handle tasks such as maneuvering a module into a docking berth, but for finer work—for example, orbital assembly of a satellite—the cherry picker offers the advantage of human judgment and dexterity. The space-suited astronaut can control both his own work station and the mechanical arm to which it is affixed, maneuvering freely to perform a wide range of assembly and construction jobs.

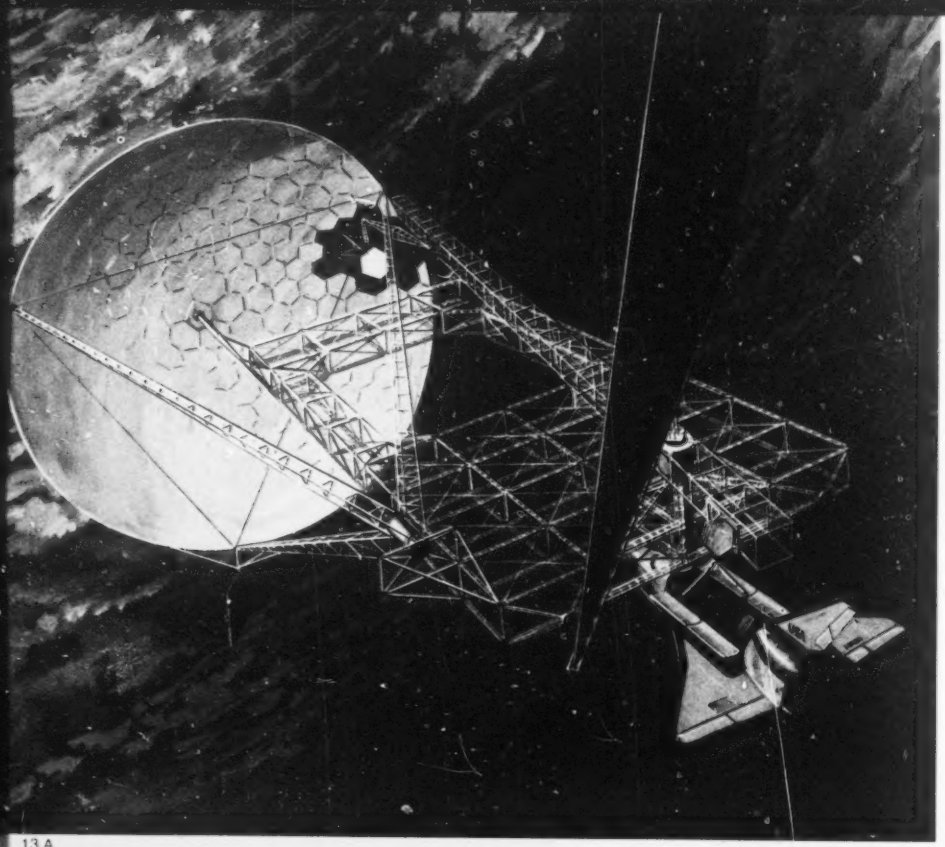
Another Grumman idea, illustrated in Photo B, is the Proximity Operation Module or "Proxops"; it enables an astronaut, operating from an Orbiter or an OTV, to capture a satellite in need of servicing. Grumman Aerospace has made a specialty of designing ancillary vehicles and equipment for advanced space operations. The company is already developing or conducting studies of such systems as a free-flying, one-man spacecraft for performing inspection and repair jobs on or near the space station; an automated beam builder that converts spools of aluminum into building-block beams for space construction; a pressurized cherry picker in which a shirt-sleeved "astroworker" operates a pair of manupulators for repair and construction tasks; a work crew transporter, a Spacelab-like pressurized cylinder mounted within an Orbiter's cargo bay, for moving as many as 25 astroworkers from Earth to low Earth orbit; a manned Orbital Transfer Vehicle; and, for future large-scale construction in space, a heavy lift launch vehicle capable of delivering to a construction site a million pounds of materials on a single flight.



12 A

12 B





13 A

13. The space station is an important step toward another long-considered space goal: construction in orbit. For building very large structures, the station could serve as construction headquarters, as a warehouse for materials brought up from Earth, possibly as a factory for in-space production of building beams; an Orbiter-type vehicle would deliver the materials from space station to construction site and also serve as an on-site work platform. Examples of projects wherein space construction techniques might be employed—as opposed to modular assembly techniques--are giant antennas such as the single-disn system shown in the Grumman Aerospace concept (left) and the multi-dish system envisioned by Rockwell International. Huge antenna structures like these, some measuring hundreds of yards in diameter, are being seriously considered for development. They offer many advantages in communications, Earth resources monitoring, military Earth surveillance and other areas. One big antenna could replace as many as 100 current satellites and make possible such advances as routine electronic mail or the "Dick Tracy" wrist radio.

13 B

DEFENSE AND THE

By The Honorable Caspar W. Weinberger
Secretary of Defense

ECONOMY

Vital improvements to our national security have not been without their cost. There are some who charge that the sacrifices required to revitalize America's defenses are too great. I want to address that charge and to dispel some of the myths that are being circulated about the economic effects of the defense budget; for myths they are.

Some of those who have doubts have chosen to base them upon the notion that the defense budget should be treated just like other parts of the federal budget or used as an active tool of economic policy. I disagree. Our defense budget, and our military posture must be geared to the threat we face now and in the years ahead. We should not spend a cent more than the actual threat we face requires, and we are not. Indeed some military critics think we are not doing enough or as soon as we should.

As you know, more than two decades ago the Soviet Union began amassing a huge military arsenal, an ominous buildup that they have continued despite staggering economic problems. As the arms buildup gained momentum, they attained quantitative superiority in conventional arms. By the 1970s, they were dedicating from 12 to 14 percent of their gross national product to their military. The largest portion of their expenditures was for modern arms. By the 1980s that investment had widened the gap in their conventional superiority and given them for the first time a strategic edge.

This would never have happened if the United States had seen to its own defenses. For a myriad of reasons—post Vietnam disillusionment, detente, hopes for SALT and general wishful thinking that ignored the hard facts of what the Soviets were doing all through this period—we allowed Defense's share of the budget to fall to the lowest levels since pre-World War II.

Now that it is apparent to all, or almost all, what military strength the Soviets have acquired, we must substantially increase defense spending, and do it now, and keep it up for several years. To do otherwise is to court danger and invite aggression against us.

Can our economy sustain the defense effort required?

This is a reasonable question. Fortunately, all our history indicates clearly that the answer is yes. In this current fiscal year, the Department of Defense outlays will amount to about 5.9 percent of our Gross National Product (GNP). The buildup proposed by the Administration will increase defense outlays to 7.2 percent of GNP in fiscal year 1987. These figures are fairly low by the standards of the 1950s and early 1960s. In 1955, for example—and 1955 was a boom year for the economy—defense outlays amounted to 9.2 percent of the GNP. Over the years 1954-1964, defense outlays averaged 8.9 percent of GNP. These figures demonstrate that defense took a larger part of GNP during that period of rapid, sustained economic growth than it will during any year of our proposed buildup.

Since defense spending is large enough to have a noticeable direct impact on two or three dozen industries and indirectly has some impact on the economy as a whole, another legitimate set of economic issues concerns the overall management of the defense budget and the pace of the increase.

Will the defense buildup lead to bottlenecks?

The question most ofen asked is: will the defense buildup lead to bottlenecks that reduce the effectiveness of the program and harm the economy? Again, the answer is *no*.

The seasonally adjusted unemployment rate in the United States has recently been over 9 percent. The average rate of capacity utilization in United States industry has been only about 70 percent, and there are industries in the defense sector that are utilizing less than half of their available capacity. I am surprised that the question of bottlenecks should be raised so frequently.

Bottlenecks occurred in a handful of defense industries in 1979 and 1980. The problems experienced then primarily involved suppliers of components and materials to the aerospace industries. For example, strikes aimed at suppliers of ball bearings and problems with obtaining tungsten caused an increase in lead times for procurement of jet engines. Delays in production of some forgings also led to increases in the lead times for procurement of landing gear.

These problems have since abated. But directly or indirectly the Defense Department buys from thousands of industries and no one can assure you that minor, temporary bottlenecks may not arise in some of these industries over the next few years. We in the Defense Department think that the concern with bottlenecks is greatly exaggerated, but we have taken initiatives to deal with any specific bottlenecks that may arise. In addressing the possibility of bottlenecks, we first must consider the nature of the defense industrial base.

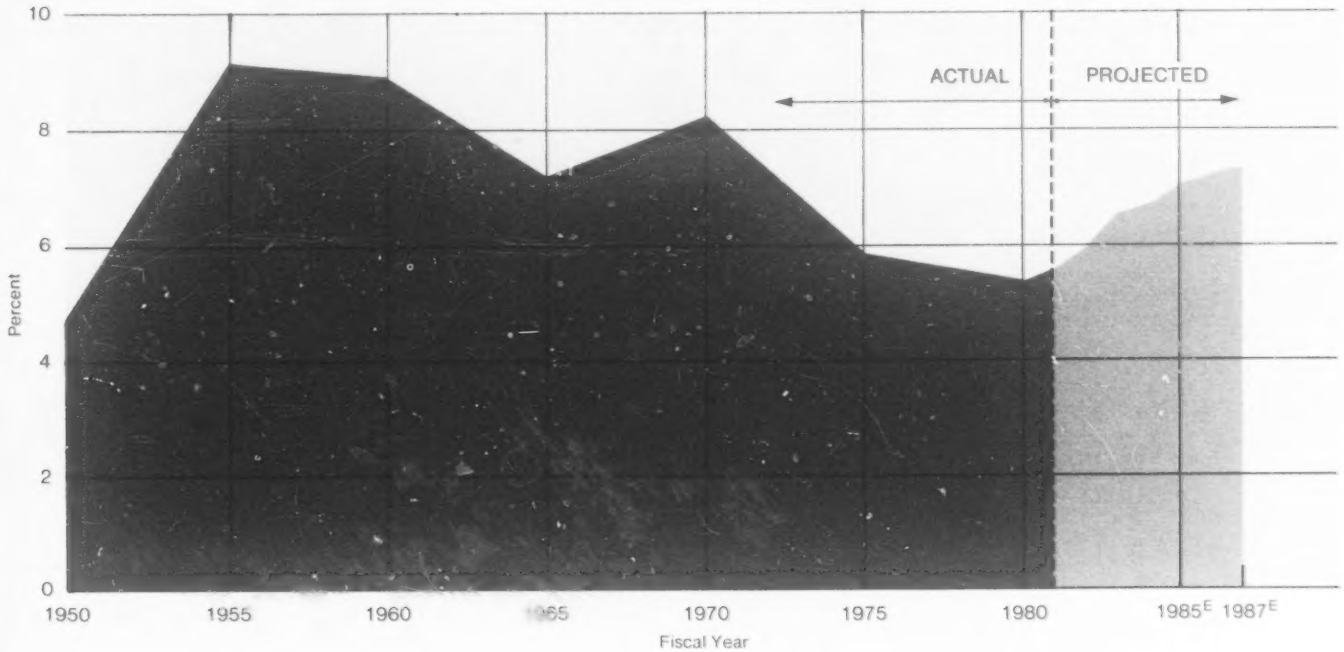
Where does DoD buy?

Our purchases are very widely spread. We estimate that in 1983, 62 industries will each supply $500 million or more (1980 dollars) in goods purchased directly by DoD or used in production of goods bought by DoD. An estimated 43 industries will have direct or defense induced sales in excess of $1 billion and 24 industries will exceed $2 billion sales.

However, defense demands are not necessarily a large part of total demands for these industries. Our analysis indicates that in 1987, out of the more than 400 American industries, there will be only 35 for which defense and defense-related demands will account for more than 10 percent of total sales. Furthermore, the total output of these 35 industries (civilian plus defense) will represent less than 5 percent—and their defense work less than 2 percent—of total United States industrial output in 1987.

Secretary Weinberger delivered these remarks before the Atlanta Chamber of Commerce.

NATIONAL DEFENSE AS A PERCENT OF GROSS NATIONAL PRODUCT, 1950-1987



Source: Aerospace Industries Association

Do we have the capacity to produce the goods in the defense budget?

Consider how the DoD dollar is spent. About half of FY 1983 DoD outlays are payments to military and civilian employees and retired military personnel and related costs. The remaining half goes for procurement of goods and services, most of which are supplied by private firms. Thus, in contrast to most other government agencies, DoD is a large purchaser of goods produced by and for the private sector.

DoD's purchases fall into two broad groups. First, DoD buys a wide range of items that are primarily produced for the civilian economy—gasoline and other petroleum products, general purpose spares, automobiles, banking services, food, real estate, and a wide variety of other goods and services. Altogether, these "off-the-shelf" items account for roughly twenty percent of DoD outlays. Second, DoD buys highly specialized military goods—fighter aircraft, tanks, missiles, ships, among other items.

I do not think it is necessary to ask if the twenty percent of DoD spending that goes for off-the-shelf items will lead to bottlenecks. Defense spending is too widely dispersed and too small a part of the sales of the industries involved for that to be a sensible question. If bottlenecks exist anywhere, we would expect to find them in the industries that produce specialized military goods or parts that go into these goods.

I cannot address each of the defense industries here, but let us look at one large example to support our view that the defense industries generally have ample capacity to meet the demands of our budget. In 1985, at the height of the proposed buildup, we will buy 420 fighter/attack aircraft. That is an increase over the number we are buying now, but 25 percent less than we bought as recently as 1980 and much less than the 1,000 fighters we bought in 1968 at the height of the Vietnam war. At that time, one plant—the McDonnell Douglas facility in St. Louis—was producing at a rate of 70 fighter aircraft per month, or at about twice the rate that we plan to buy from all suppliers in 1985.

It is also important to note that we have restructured the defense guidance to emphasize and focus on lead time problems. The first priority is to ensure that we have the capacity our current procurement program requires. Our new DoD acquisition improvement program is structured to reduce long delivery times. The program is specifically aimed at those problems that discouraged industry from risking the necessary capital investment. Prominent among these have been instabilities in the defense program.

Aside from the structural changes we have instituted to correct these fluctuations, the most effective solution is to stick to a reasonable and steady defense program. That, indeed, is one of our most important long term goals. Peaks and valleys in defense spending are as insidious to national security as they are, logically, to the industrial effort required to ensure it. The defense of the United States must not be based upon the ever shifting ground of transitory economic concerns.

Would the defense buildup crowd out civilian demand?

But we should also remember that the economic situation we are looking at today is *not* one which the proposed buildup will harm. I have heard a lot of talk about the "crowding out" effect on civilian demand of defense spending. The facts say otherwise. Nearly three quarters of defense outlays are accounted for by the sum of personnel and personnel related costs and purchases of goods and services also supplied to the civilian economy. Purchases of this sort not only do not crowd out civilian demand—on the contrary these purchases enhance our civilian production capacity.

Nor do defense purchases of other items, such as fighter aircraft, crowd out civilian demands. Because of course, civilian demands for such exotic items is fortunately, nonexistent. This example

may sound extreme, but it makes an important point. Completed weapons systems are produced by specialized industries. For example, in the proposed 1983 defense budget, we would buy only about a dozen airplanes made on assembly lines used to produce large commercial passenger or transport jets. There is more than ample unused capacity on the lines, unfortunately. Almost all of the other planes we will buy are produced in specialized facilities.

In fact, our critics often agree with this perspective. They seem to be concerned with indirect effects that work in a different way through interest rates, investment and deficit. And although DoD is not in the economic policy business, we have looked into these issues to some extent.

We have used well-known private models of the economy to examine whether President Reagan's new defense spending will crowd out private business investment. We compared the effect of defense outlays held to the level proposed by President Carter in his January 1981 budget with the Reagan Administration's defense expenditure projections. These analyses showed that, while increased defense expenditures have a small effect on interest rates, private investment will actually be slightly *higher* with President Reagan's overall economic program and defense expenditures than with the Carter defense budget.

Would cutting defense spending significantly change the deficit?

Defense cuts would not significantly reduce the federal deficit in the next few years for three important reasons.

First, much of this year's defense spending is determined by prior commitments, and by the minimum requirements for daily operation of the military services. For example, it has recently been estimated that 94 cents of each spending dollar stems from ongoing programs at the start of FY 1983, which must either continue, or waste what has gone before. That leaves only 6 cents allocated to new programs.

The second factor is related to the first. Even very large cuts in procurement budget authority would yield only modest outlay savings in the budget year. Elimination of the B-1,and the M-X, cruise missiles, two nuclear carriers and a Trident submarine, which account for $19.5 billion in total obligational authority, would yield only $5 billion in outlay savings in FY 1983.

The third factor is related to how defense spending affects the economy. Many of the dollars spent on defense go for the production of materiel, thus creating jobs, stimulating investment, and generating tax revenues, both individual and corporate. As a result, a dollar cut in defense outlays will yield only about 50 cents in savings on the deficit in the budget year.

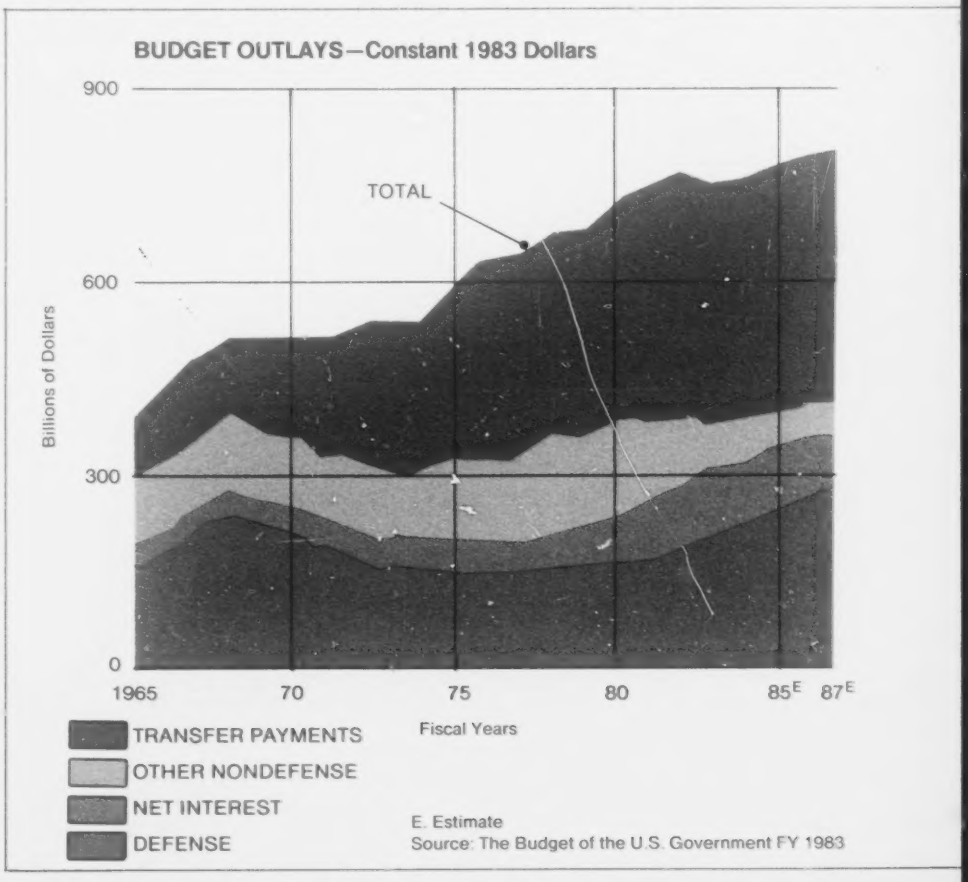
On the other hand, transfer payments have a much more direct effect on the deficit. Transfer payments are not generally taxed. Moreover, they usually go to non-durable consumer goods, with a lower investment component, and thus have a lower multiplier effect than defense spending. Our projections indicate that each dollar reduction in transfer payments provides nearly a dollar's reduction in that year's federal deficit.

Transfer payments have been one of the most rapidly growing elements of federal spending in the last two decades. Between 1960 and 1979, total federal outlays approximately doubled, while federal transfer payments more than tripled, increasing by 339 percent. In constant 1982 dollars, federal transfer payments grew from an average of $1,300 per U.S. household in 1960 to more than $3,600 per household by 1979. In contrast, defense spending was about $3,000 per household in 1960, but had fallen to about $2,000 per household in 1979.

This is not to say that defense spending should be regarded as a way to stimulate the economy. It should not. This Administration believes most strongly, as I think you know, in the ability of private enterprise to create new wealth. But because defense spending does produce considerable tax revenues, its reduction does not represent an easy way to reduce the federal government's deficit.

Moreover, the adverse signals that would be sent abroad if we made massive curbs in our defense plans, only a year after announcing vitally needed increases, would far outweigh any small effect on the deficit that would flow from such an action. Indeed, such cuts would only encourage our adversary and dishearten our allies. Such cuts would also again impose a "start and stop" pattern on our defense efforts, creating program instability and discouraging investment.

In the end, the debate over the level of defense spending comes down to a question of priorities. What can have a higher priority than peace with freedom? The answer, of course, is nothing. But even if achieving the security needed for this meant some dislocations in the economy—and it does not today—who would suggest any other course? Surely no one would propose anything that reduces or risks our ability to defend ourselves. For the economy exists to serve people's needs, and our foremost need is the nation's security. Without security, nothing else can survive and flourish as we know it.



Kudos from Congress

"At a time when affairs on Earth appear bleak, when there is an overwhelming tendency to dwell on all that is wrong with ourselves, with our country, the success of the Space Shuttle serves to remind us and encourage us of what is good, what we can accomplish despite tremendous odds, and what potentially marvelous things the world and the universe hold for us."

So stated Senator Alan Cranston (California) when he introduced, in behalf of 25 senators, a resolution (as Senate Concurrent Resolution 114) congratulating NASA and industry contractors on the successful completion of the Space Shuttle Orbital Flight Test Program, which paved the way for operational Shuttle service beginning in the fourth quarter of 1982. The Senate agreed to the resolution and it became a pronouncement of the full Congress when the House of Representatives concurred, substituting the House Resolution Number 541.

Asking "what's next?" in space, Senator Cranston cautioned that "we cannot afford to sit by idly . . . If we do not continue our efforts, we can be sure that our leadership in space will shortly be relinquished to our European and Japanese competitors. This is not just a question of national pride and 'being first.' It is a question of our economy. Our technological edge is our strongest competitive advantage with our trading partners. We simply cannot afford to lose it. Our space policy plays an important role in maintaining this technological edge."

Resolution co-sponsor Senator S. I. Hayakawa (California) added a salute to "the most recent of many inspirational achievements of the U.S. space industry. Through the National Aeronautics and Space Administration, our country has provided example after example of what heights America can reach when its collective energies are summoned. The Space Shuttle test flight program's success is the result of 10 years of development which exhibited for all the world the step-by-step process demanded to produce a near-perfect reusable space vehicle."

The congratulatory resolution cited NASA, the astronaut corps, the principal Shuttle contractors—Rockwell International, Martin Marietta Aerospace and Thiokol Corporation—and "the thousands of Shuttle subcontractors throughout the United States."

HOUSE JOINT RESOLUTION 541

To congratulate the National Aeronautics and Space Administration and all persons involved in the success of the test flight phase of the Space Shuttle program.

Whereas when the Space Shuttle *Columbia* flew through a blazing re-entry and skimmed to a perfect landing on the 4th of July 1982, at Edwards Air Force Base, California, the National Aeronautics and Space Administration successfully completed the test flight phase of the Space Shuttle and began a new era of operational Space Shuttle missions;

Whereas in four test missions, the Space Shuttle *Columbia* a reuseable spaceship designed to provide routine space travel for a wide variety of scientific, commercial and military payloads at reduced costs and with a high reliability of success, lived up to its promise as the most advanced spacecraft in the world;

Whereas in four test missions, the *Columbia* was lifted from Earth, orbited in the vacuum of space like a satellite, operated a variety of scientific experiments, tested the capability of the remote manipulator system to deploy satellites in orbit and to retrieve satellites, descended into the Earth's atmosphere, was piloted by astronauts like a conventional winged airplane, and was landed at Edwards Air Force Base, California, and at White Sands Space Harbor, New Mexico;

Whereas the Space Shuttle *Columbia*, the new completed Space Shuttle *Challenger*, and the sister Shuttles *Discovery* and *Atlantis* now under construction, will be able to fly repeatedly back and forth from space as an operational space transportation system;

Whereas the Space Shuttle orbiters will accommodate an unprecedented variety of payloads, including a fully equipped scientific laboratory (Spacelab) provided by the European Space Agency, underscoring the commitment of the United States to international cooperation in space activities;

Whereas using the unique qualities of the space environment (weightlessness and a near perfect vacuum) the Space Shuttle Orbiters will be used for experiments to produce special alloys, metals, glasses, crystals, and pharmaceuticals that cannot be performed on Earth;

Whereas the Space Shuttle Orbiters will place in orbit satellites to observe the Earth's weather, provide improved communications, discover new mineral resources, monitor crop and timber yields, help United States forces to navigate, and monitor arms control agreements;

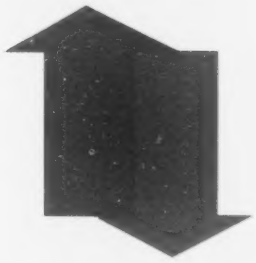
Whereas the Space Shuttle Orbiters will also place in orbit the most powerful space telescope and will launch scientific probes to explore the planets;

Whereas the Space Shuttle program is a national enterprise, geographically and technologically, requiring tens of thousands of skilled workers to design, develop, test and evaluate the various Space Shuttle components;

Whereas the Space Shuttle program has been judged by independent research organizations to have a positive effect on the national economy, creating jobs, reducing inflationary pressures and forwarding the development of advanced technologies; and

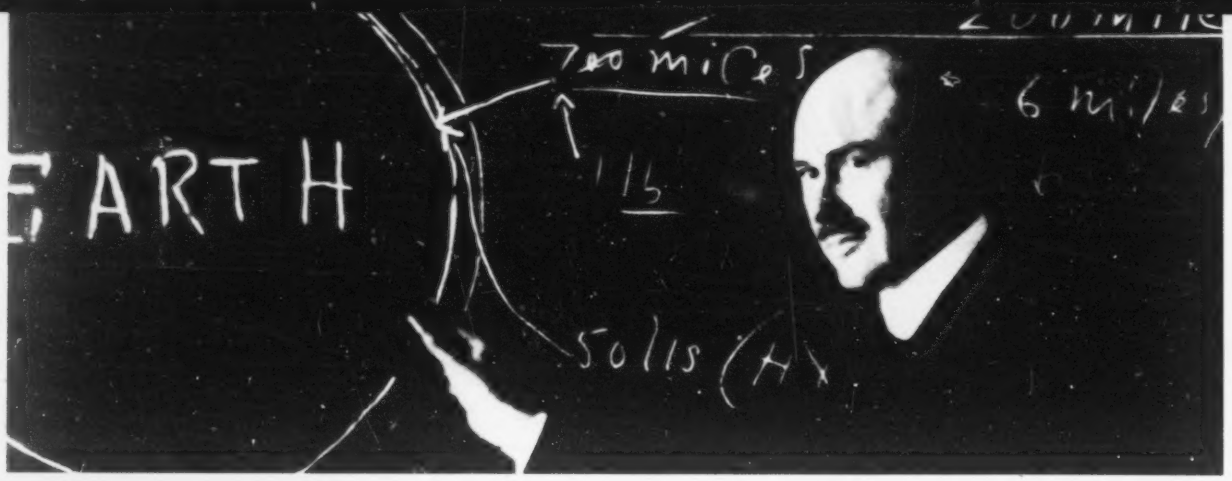
Whereas the Space Shuttle program is a source of great national pride and the United States now holds world leadership in its proven ability to operate a reusable Space Shuttle: Now therefore, be it

Resolved by the Senate (the House of Representatives concurring), That the Congress of the United States congratulates the National Aeronautics and Space Administration, the members of the astronaut corps, prime contractor Rockwell International, associate contractors Martin Marietta and Thiokol, the thousands of Shuttle subcontractors throughout the United States, and the tens of thousands of dedicated Space Shuttle workers who contributed to the successful completion of the Space Shuttle test flight period and to the entry of our nation into a promising new era of spaceflight for the benefit of the people of the United States and all mankind.



The Space Shuttle Orbiter is built by Rockwell International's Space Systems Group, which is also responsible for integration of the overall NASA Space Transportation System. Associate contractors are Thiokol Corporation, which produces the Shuttle's solid rocket boosters, and Martin Marietta Aerospace, manufacturer of the external fuel tank. Shuttle contracts are managed by NASA's Johnson Space Center and Marshall Space Flight Center. Other major contractors in the Shuttle program include:

Abex Corporation
Aerojet General Corporation
Autonetics Group (Rockwell)
Avco Corporation
The Bendix Corporation
The Boeing Company
CCI Corporation
(The Marquardt Company)
Collins Radio Group (Rockwell)
Columbus Aircraft Division (Rockwell)
Colt Industries Inc. (Menasco Inc.)
The Garrett Corporation
General Dynamics Corporation
General Electric Company
The BF Goodrich Company
Grumman Corporation
Hamilton Standard Division
(United Technologies Corporation)
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation, Federal Systems Division
ITT Cannon
Lear Siegler, Inc.
Lockheed Corporation
Los Angeles Aircraft Division (Rockwell)
McDonnell Douglas Corporation
Northrop Corporation
Parker Hannifin Corporation
Pratt & Whitney Division
(United Technologies Corporation)
RCA Corporation
The Singer Company
SPAR Aerospace
Sperry Corporation
Sunstrand Corporation
Teledyne CAE
TRW Inc.
Tulsa Division (Rockwell)
United Space Boosters, Inc.
(United Technologies Corporation)
Vought Corporation
Westinghouse Electric Corporation



Dr. Robert H. Goddard, teaching a physics class at Clark University in 1924.

GODDARD: Father of Space Flight

October 4 marks the silver anniversary of space flight. It was on that date, 25 years ago, that the Soviets launched Sputnik 1, the first man-made object to achieve orbit.

Coincidentally, October 5 is the 100th anniversary of the birth of Dr. Robert Hutchings Goddard, the father of modern rocketry. It was Goddard who not only developed the principles of space launch—as did others—but also backed his theoretical work with practical experiments that demonstrated the feasibility of liquid rocket propulsion. So, whether they like it or not, the Soviets must share anniversary honors with the United States; they launched the first satellite but an American provided the developmental base from which all launch vehicles evolved.

During his lifetime, Robert Goddard received 83 patents related to rockets and space systems. Among his many developments were gyro stabilization, multistage rockets, exhaust deflectors and aerodynamic vanes for guidance, turbopumps, clustered motors and gimbal-mounted engines for steering. He developed automatic sequencing launch controls, an optical tracking system and the parachute recovery technique. All of these developments, though considerably refined, are still in use.

Goddard started thinking about space flight while still a teenager in high school at Worcester, Massachusetts. He pursued the dream by taking a science course at Worcester Polytechnic Institute, from which he graduated in 1908. Then he enrolled at Clark University in Worcester, receiving his master's degree in 1910 and a doctorate in physics in 1911. As student, fellow, professor and rocket researcher, Goddard was to be associated with Clark for most of his life, and Clark University is spearheading this year's Goddard centennial celebration.

At Clark, as part-time teacher and part-time experimenter, Goddard began his practical work on rockets in 1914. He did not, of course, invent the rocket; it had been known for centuries. Nor was he the first space theorist; in 1903, the Russian schoolteacher Konstantin Tsiolkovsky had published a paper outlining a technical basis for rocket-powered space flight. But Goddard went beyond Tsiolkovsky by actually building and testing rocket hardware, using his own money at first, later supported by grants from the Guggenheim Foundation, the Smithsonian Institution and Clark University.

After a dozen years of research and development, Goddard launched the world's first liquid propellant rocket on March 16, 1926 at Auburn, Massachusetts; it flew for 2.5 seconds and reached an altitude of 41 feet. Its performance was hardly impressive, there were no reporters on hand and no pictures were taken of the flight—but, although hardly anyone knew it, a new era had started.

Goddard flew three more rockets at Auburn, including the first instrumented vehicle on July 17, 1929. On that occasion, Goddard got plenty of attention—two ambulances, police cars, a search plane and scores of reporters and spectators, drawn to the launch site by reports of an airplane crash. The publicity brought a ban against rocket testing at Auburn.

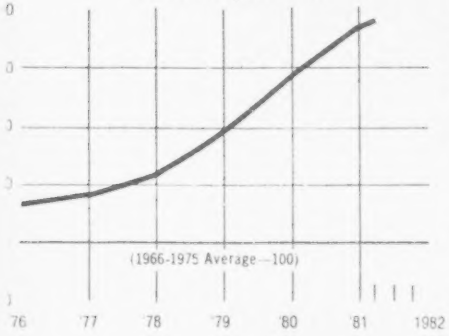
During the 1930s, Goddard continued his experiments at a ranch near Roswell, New Mexico. He conducted many successful firings, including—in 1935—the first supersonic flight. During this period, Goddard's rockets reached a high degree of sophistication; they contained virtually all of the devices that later appeared in the German V-2, the first large, practical rocket. There is evidence that the Germans drew upon Goddard's work, which bolsters his status as the "father of space flight," since the V-2 served as a departure point for both U.S. and Soviet space launch vehicles.

Robert Goddard died in 1945 while working for the government on liquid rockets for assisted takeoff of aircraft; the military had seen no possibilities for liquid rockets in warfare when Goddard offered his services in 1941. He had never been able to reach the extreme altitudes he sought, 20 miles or more; in fact, his best shot reached an altitude of 9,000 feet. But his combined theoretical and hardware development work over a span of three decades created a foundation of space knowledge for what happened 25 years ago on October 4—and, to considerable extent, for what has happened since.

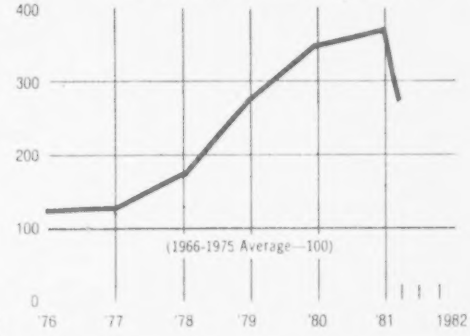
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

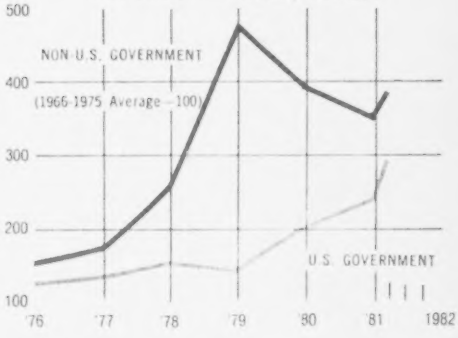


Value of Civil Aircraft Shipments[r]



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 1st QTR. 1982
AEROSPACE SALES: TOTAL	Billion $	Annually	24.2	62.2	68.9	69.7
	Billion $	Quarterly	6.1	16.0	18.7	16.8
AEROSPACE SALES: TOTAL	*Billion $*	*Annually*	*25.6*	*34.3*	*35.5*	*35.3*
(In Constant Dollars, 1972=100)	*Billion $*	*Quarterly*	*6.4*	*8.5*	*9.3*	*8.3*
AEROSPACE PRIME CONTRACT AWARDS: TOTAL	Billion $	Quarterly	5.8	19.7	19.6	20.5
U.S. Government	Billion $	Quarterly	4.1	10.3	12.7	12.3
Other Customers	Billion $	Quarterly	1.7	9.4	6.9	8.2
BACKLOG (Major Aerospace Mfgrs): TOTAL	Billion $	Quarterly	28.6	95.4	94.3	98.7
U.S. Government	Billion $	Quarterly	15.9	40.0	45.3	48.7
Nongovernment	Billion $	Quarterly	12.7	55.4	49.0	50.0
DEPARTMENT OF DEFENSE						
Aerospace Obligations: TOTAL	Million $	Quarterly	2,712	5,384	6,244	8,747
Aircraft Procurement	Million $	Quarterly	1,986	4,241	4,915	7,015
Missiles Procurement	Million $	Quarterly	726	1,143	1,329	1,732
Aerospace Outlays: TOTAL	Million $	Quarterly	2,405	3,886	5,006	4,844
Aircraft Procurement	Million $	Quarterly	1,741	3,055	3,940	3,888
Missiles Procurement	Million $	Quarterly	664	831	1,066	956
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million $	Quarterly	780	1,522	1,148	1,688
Expenditures	Million $	Quarterly	789	1,077	1,422	1,155
EXPORTS						
Total (Including Military)	Million $	Quarterly	1,038	4,253	4,344	4,153
New Commercial Transports	Million $	Quarterly	345	1,699	1,680	1,410
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	1,211	1,203	1,183
Aircraft	Thousands	End of Quarter	650	665	648	634
Missiles & Space	Thousands	End of Quarter	114	117	123	123
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	9.98	10.91	10.93
PROFITS						
Aerospace — Based on Sales	Percent	Quarterly	2.7	6.0[a]	3.1	3.2
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	4.7	4.3	3.8

* 1966-1975 average is computed by dividing total year data by 4 to yield quarterly averages.
† Preceding period refers to quarter preceding latest period shown.
a Reflects unusually high level of non-operating income.
r Revised.

Source: Aerospace Industries Association

AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St. N.W. Washington, D.C. 20036

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